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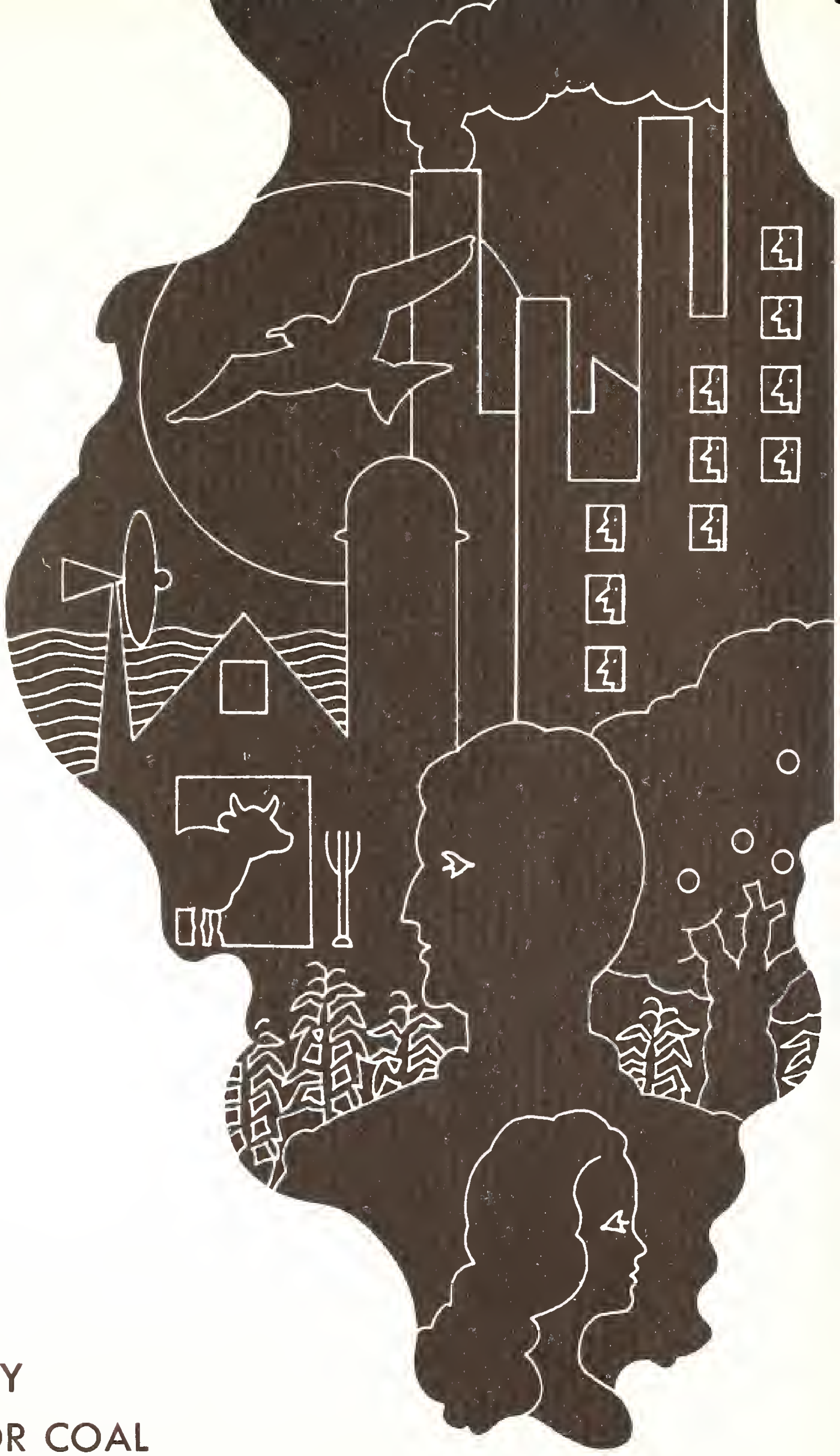

LINOIS LANDS AFFECTED BY
NDERGROUND MINING FOR COAL

ILLINOIS LANDS AFFECTED BY UNDERGROUND MINING FOR COAL

By

Jack R. Nawrot, Ronnie J. Haynes,
Perry L. Pursell, James R. D'Antuono,
Richard L. Sullivan, and W. D. Klimstra

Cooperative Wildlife Research Laboratory
Southern Illinois University, Carbondale

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ABSTRACT

The Cooperative Wildlife Research Laboratory of Southern Illinois University at Carbondale surveyed all lands affected by underground mining for coal as of 1 September 1976; field research was conducted from October 1975 to August 1976. The primary purpose of the survey was to delineate locations, surface ownership, and environmental problems associated with abandoned mine sites.

Various historical and governmental records provided locations for 4,076 abandoned mines in 70 counties. The greatest number of abandoned mines were recorded in Fulton (366), Peoria (194), Vermilion (310), St. Clair (292), and Williamson (329) counties. Of the 4,076 abandoned mines recorded in Illinois, 1,745 (42.8 percent) no longer existed due to other developments. These developments included: 1) surface mining (481 sites); 2) agricultural activities such as row crops, pastures, and animal lots (606 sites); 3) residential facilities (439 sites); 4) industrial complexes (126 sites); and 5) miscellaneous items such as landfills or dumps, highway construction, and recreational areas (93 sites). Over one-third (1,361 sites) of the recorded sites had reverted to a natural condition with little or no evidence of past mining. Specific location information for 239 mines was unavailable; however, it is assumed that these mines had reverted to a natural condition. Access to one site was denied by the landowner; however, observation of aerial photos revealed no discernible surface disturbance. Four abandoned mines were being utilized by active surface or underground mine operations for processing or storage of coal, and 15 abandoned mines

associated with surface mines had previously been inventoried.

Evidence of past mining existed at 711 abandoned mine sites; 11 of the sites consisted of only foundations, or hazardous or flowing openings with no associated affected acreage. Disturbance associated with the 700 abandoned sites totaled 6,955.9 acres. Affected acreage included gob refuse (3,943.5 acres), slurry refuse (693.8 acres), tipple areas (813.2 acres), water impoundments (647.7 acres), and off-site affected areas (857.7 acres). Disturbed land was unequally distributed among 55 counties. Eleven counties (Franklin, Williamson, Christian, Macoupin, Saline, Perry, St. Clair, Madison, Randolph, Montgomery, and Bureau) accounted for over 80 percent (5,622.9 acres) of the affected land with an average of 21.4 acres of disturbance for the 263 mine sites. In contrast, the remaining 44 counties accounted for less than 20 percent (1,330.0 acres) of the affected land, with an average of only 3.0 acres for 437 mine sites.

Of the total affected acreage, only 26.1 percent (1,812.8 acres) resulted from mines operated by individuals or small companies. Although less than one-fourth (172 sites) of the existing abandoned mine sites had been operated by major mining companies, almost three-fourths of the affected land (4,980.0 acres) was associated with these operators. Over one-half (3,776.6 acres) of the total disturbed land was located in agricultural locales. Residential areas (rural and urban), as well as industrial areas, encompassed over one-fourth (1,751.1 acres) of the abandoned mine acreage. Of the 700 mines with affected acreage, 564 were owned by private individuals. Private ownership accounted for over one-half of the affected acreage in the state, with an average of 6.2

acres per mine site. In comparison, mining companies owned only 49 abandoned mine sites, but these sites accounted for 2,318.5 acres and averaged 47.3 acres per mine site.

Gob refuse totaling 3,943.5 acres varied from 0.1 to 323.0 acres at 638 mines. Five counties (Franklin, Christian, Saline, Williamson, and Macoupin) contained over one-half of the total gob acreage recorded. Severe gully erosion was associated with 2,706.7 acres, while rill and sheet erosion affected 685.1 and 551.7 acres, respectively. Gob volume for the entire state totaled an estimated 71.4 million cubic yards. Extensively burned (burned over 50 percent of the total area) gob piles contained over 28 million cubic yards of refuse. Actively burning gob refuse was recorded at only six sites; the amount burning was minor.

Herbs, shrubs, and small trees totaling 1,900.6 acres comprised the predominant successional stage on gob refuse. Density of ground cover vegetation varied from barren or sparse on 1,710.4 acres to excellent on 165.9 acres. Small sites exhibited scattered to uniformly distributed vegetation, whereas large sites were characterized by vegetated perimeters or lower slopes, and barren to sparsely vegetated interiors or upper slopes. Broom-sedge (*Andropogon virginicus*), three-awn grasses (*Aristida* spp.), blackberry (*Rubus* spp.), and rose (*Rosa* spp.) were recorded as dominant species on over 40 percent of the gob areas. Dominant overstory vegetation on gob refuse areas included wild cherry (*Prunus* spp.), elm (*Ulmus* spp.), shingle oak (*Quercus imbricaria*), and pin oak (*Q. palustris*).

Slurry refuse areas totaling 693.8 acres varied from 0.1 to 99.6 acres at 53 impoundments (38 mines). Three counties (Franklin,

Williamson, and St. Clair) contained over 60 percent of the abandoned slurry acreage. Sheet erosion was associated with 320.9 acres, while gully and rill erosion affected 236.1 and 136.7 acres, respectively. Ground cover density ranged from barren to poorly vegetated on almost one-half (326.9 acres) of the slurry areas. Phragmites (*Phragmites australis*) was an important ground cover species of moist slurry sites, while broom-sedge occurred most frequently on dry sites. Overstory vegetation occurred on only 10 sites.

Tipple areas totaling 813.2 acres varied from 0.1 to 51.0 acres at 192 sites. Six counties (Franklin, Williamson, Saline, Macoupin, Montgomery, and Perry) contained over 70 percent of the total tipple acreage recorded. Potentially hazardous openings, defined as unsealed openings into the mine works and openings flooded or partially filled with debris, were recorded at 52 mines. Unlike sparsely vegetated gob and slurry areas, dense uniformly distributed vegetative cover similar to that of adjacent undisturbed areas characterized many tipple sites. Fair to excellent ground cover vegetation occurred on over 56 percent (459.8 acres) of the tipple areas.

A total of 109 water impoundments were recorded at 89 abandoned mines. Impoundments totaling 647.7 acres ranged in size from 0.1 to 56.3 acres. Of 49 impoundments which were receiving or had received pollutional input, 36 were considered potential problem impoundments (197.5 acres).

In addition to on-site disturbance associated with refuse and tipple areas, 22 off-site affected aquatic areas and 131 affected off-site terrestrial areas were identified. Barren or sparsely vegetated

terrestrial areas totaling 821.5 acres ranged in size from 0.1 to 73.0 acres. Affected off-site aquatic areas totaling 36.2 acres included adjacent ponds and poorly drained stagnant water areas which received and held runoff from mine areas.

Of the total affected acreage (6,955.9 acres), approximately 5,000 acres representing 508 mine sites were identified as potential problem areas. Deeply eroded, barren refuse areas, as well as potentially hazardous or flowing openings, characterized the most severe problem areas. However, 43 percent of the potential problem sites were less than 2.0 acres.

Potential and observed mine drainage to off-site areas from the leaching of oxidized pyritic materials in exposed refuse piles, from the overflow from acid pools on refuse areas, and from the continuous drainage from abandoned underground workings was recorded at 343 sites in 40 counties. Continuous drainage was recorded at 42 sites, including 23 sites where drainage was associated with abandoned underground workings, and 19 sites where intermittent seepage from rain-soaked gob refuse occurred.

Analysis of 500 samples collected from waters on and adjacent to preparation sites at 245 abandoned mines indicated that water of poor quality was polluting Illinois waters and terrestrial areas. Water quality was within acceptable limits before reaching abandoned mine sites; however, due to drainage from refuse areas a deterioration in quality was found in below-mine waters.

In addition to 4,076 abandoned mines, 24 active underground mines were also identified, including 3 mines not reported in the 1975 Illinois

Department of Mines and Minerals Annual Coal Report. Total acreage reported for active mines (3,591.7 acres) varied from 10.0 to over 375.0 acres. The trend toward large mining operations is apparent when the total acreage recorded for active mines is compared to the total affected acreage recorded for 700 abandoned mines (6,955.9 acres). This trend toward larger mines coupled with increased emphasis on efficient land use will underscore the importance of returning areas affected by mining to productive use. In this context it will be essential for the mining industry to comply with all environmental regulations during the period of active mining and subsequent abandonment.

INTRODUCTION

The first recorded discovery of coal in North America was by Marquette and Joliet in 1673 along the Illinois River bluffs near the present city of Utica. In 1689, Father Louis Hennepin, who accompanied La Salle's expedition in 1680, published a map showing the location of a "cole mine" along the Illinois River near the present city of Peoria. Nearly a century later coal was discovered in Pennsylvania and other eastern states (Andros 1915; Illinois Department of Mines and Minerals 1944a).

During the settlement of Illinois, explorers and travellers noted outcrops of coal along the Illinois, Mississippi, and Big Muddy Rivers. The utilization of coal was limited to blacksmithing and some domestic heating. These small amounts of coal were mined from outcrops along the river bluffs or from seams near the surface (Andros 1915; Illinois Department of Mines and Minerals 1944a).

The first recorded commercial shipment of Illinois coal (1810) took place in Jackson County when a raft loaded with coal, mined from outcrops along the Big Muddy River near Murphysboro, was floated down the river to the Mississippi and then on to New Orleans. The first production (6,000 tons) was recorded in 1833 (Andros 1915) (Figure 1).

In the early 1800's the Illinois coal industry received its greatest stimulus from the St. Louis market. However, an inadequate transportation system restricted the early development of the coal industry and limited mining to areas along or near water courses. With the growth of industrial centers such as Chicago, Peoria, Rockford,

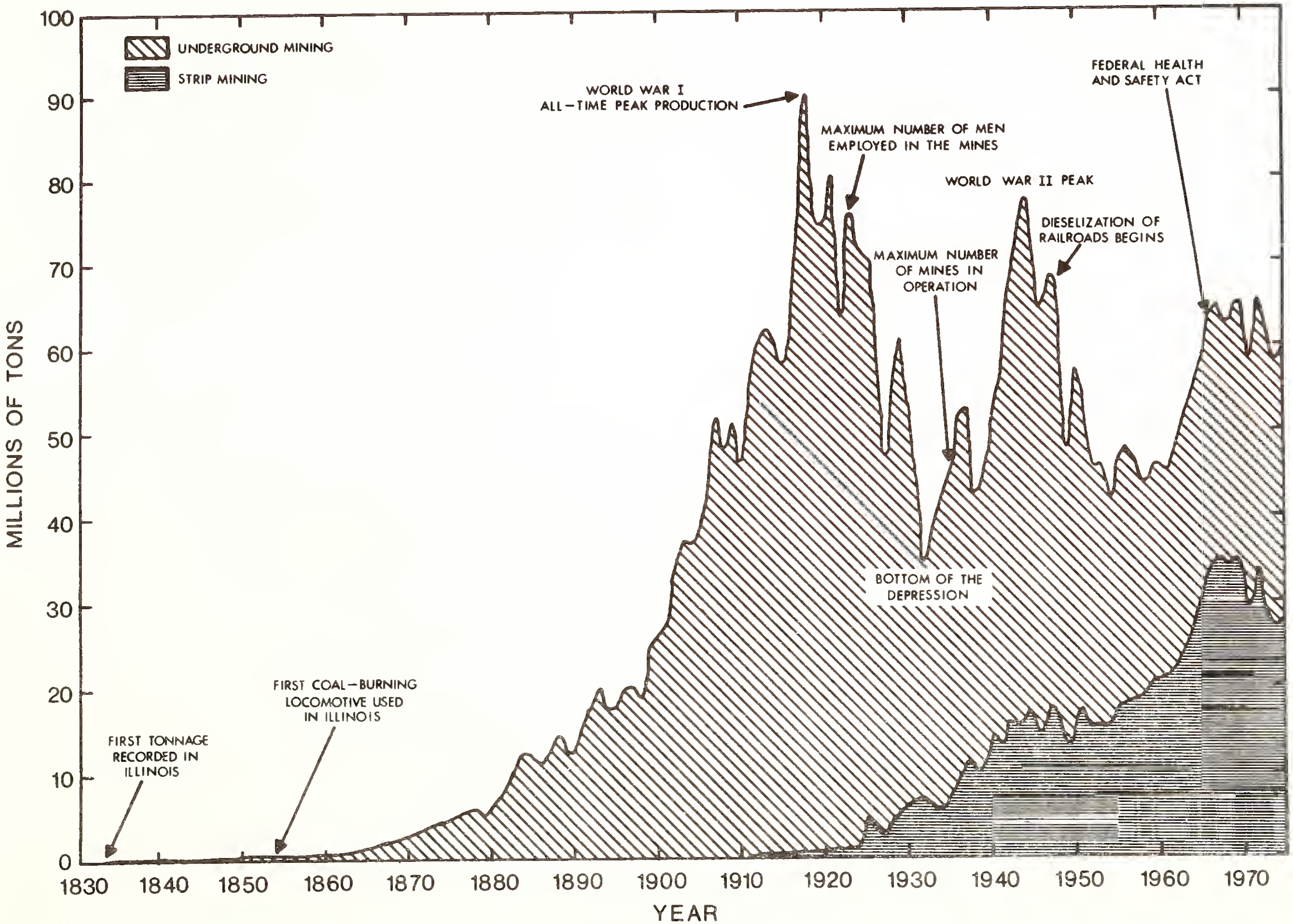

Figure 1. Coal production by underground and surface mines in Illinois from 1830 to 1975 (Carter et al. 1974).

Springfield, and Decatur, railroad construction was hastened and increased utilization of coal as an energy source occurred. The increased use of coal-burning engines after 1854 provided a significant stimulus to the coal industry, and the demand for coal grew with each mile of new railroad. The Civil War brought a rapid expansion of the state's railroads and coal production. By 1865, about 3,000 miles of track had been laid, and coal production increased from 410,000 tons in 1856 to 1.3 million tons in 1865. The trend continued, and by 1890 main track mileage equaled 10,165, and coal production had risen to 12.1 million tons (Figure 1) (Andros 1915; Illinois Department of Mines and Minerals 1944a; Krohe 1975).

The state's extensive railroad system provided a crucial transportation link between scattered coal fields and developing industrial centers. With the improved transportation system and the discovery of large deposits of coal in Williamson, Franklin, and Saline counties during the late 1800's and early 1900's, the emphasis on coal production began to shift from the older coal fields, nearest the industrial markets and rivers, to the large coal fields of southern Illinois (Andros 1915; Illinois Department of Mines and Minerals 1944a; Sibley 1965).

Between 1890 and 1918, the nation's bituminous coal industry experienced an almost continuous acceleration of production as coal monopolized the energy market. National production increased from 111 million to 579 million tons (Sibley 1965), while production in Illinois reached an all-time high of 90 million tons by the end of World War I (Figure I) (Illinois Department of Mines and Minerals 1918). Although high profit margins allowed both small and large

operations to become established, the trend was toward larger, more efficient, mechanized mines (Sibley 1965).

From about 1919 to 1940, the number of underground shipping class mines in Illinois that were dependent on the national market decreased from 370 to 139 (Illinois Department of Mines and Minerals 1918, 1975). Classification of mines, begun in 1902 by the Illinois Department of Mines and Minerals, identified shipping class mines as high production operations that shipped coal by rail, while local class mines provided coal for local use. Although the economic depression of the late 1920's and early 1930's contributed to the decline of the shipping class mines, numerous other factors were involved; the most common of them being: 1) conflicts with the labor union, 2) overproduction, 3) a considerable differential in labor costs between Illinois mines and competing mines in western Kentucky and Appalachian coal fields, 4) increased costs associated with greater mechanization of coal extraction, 5) competition from strip mines, and 6) development of substitute fuels associated with changes in consumer preferences (Brown and Webb 1941; Krohe 1975; Sibley 1965).

By 1926, the nation's coal-producing capacity was about twice that needed to supply demands. Also, production exceeded demand as coal-burning industries closed during the depression. Between 1923 and 1931, 201 shipping mines closed (54 percent of the state's total) (Krohe 1975).

After 1929, there was a striking increase in the number of truck mines (often called "gopher holes"), especially in southern Illinois. Typically, these mines were small, relatively inexpensive operations that employed few workers and produced small amounts of coal.

In spite of a decline in the number of shipping mines after 1918, new mines were opened which were mechanized and much more efficient than the older mines. By 1941, mines unable to mechanize and increase their efficiency of coal extraction and production had ceased operation (Illinois Department of Mines and Minerals 1944a; Sibley 1965).

The advent of surface mining hastened the decline of underground mining in many counties, especially in northern Illinois. Although surface mining was first recorded in the United States near Danville, Illinois, in 1866 (Weber 1971), it did not compete seriously with underground mining in Illinois until the mid 1920's (Figure 1). In 1925, about 5 percent of the state's total coal production was surface-mined; however, by 1939 surface-mine production had increased to about 24 percent (Illinois Department of Mines and Minerals 1939, 1944a.).

World War II stimulated the coal industry; by 1944, annual production in Illinois had reached 77.4 million tons (Figure 1)(Illinois Department of Mines and Minerals 1944b). However, the increase was only temporary, and production declined sharply after 1944. The coal industry lost many of its markets to oil and natural gas. Also, large wartime contracts for coal were cancelled, and diesel engines began to replace coal-burning locomotives after 1948 (Krohe 1975).

Between 1951 and 1972, total energy consumption in the United States increased by 94 percent; 77.8 percent of the total energy consumed came from oil and gas, whereas coal accounted for only 17.2 percent of the total use (Risser 1973). Illinois coal production in 1975 totaled 59.5 million tons (Figure 1); this equalled about 9.3 percent of the total production in the United States for that year

(Illinois Department of Mines and Minerals 1975; Keystone 1976).

Increasing energy consumption together with declining gas and oil reserves and numerous problems concerning the development of alternate energy sources makes the future of the nation's coal industry appear promising. In Illinois, coal-bearing Pennsylvanian strata underlie about 65 percent of the state and occur in all or part of 86 counties. Although North Dakota and Montana have larger reserves (lower rank lignite and subbituminous coals), Illinois has the largest reserves of bituminous coal (161.6 billion tons) of any state. Estimates of Illinois' reserves include coals more than 28 inches thick and greater than 150 feet deep and strippable reserves more than 18 inches thick and less than 150 feet deep. Approximately 45 percent of Illinois' reserves are considered recoverable by 1974 mining methods; 53.4 billion tons recoverable by underground mining and 12.2 billion tons by surface mining (Malhotra and Simon 1976). Although economically and technologically recoverable reserves may represent substantially less than the total estimated reserves, Illinois compares favorably with other states having bituminous reserves because of its generally thicker, more continuous, and relatively flat-lying seams. Consequently, Illinois coal will play a major role in meeting future energy needs (Hopkins and Simon 1974; Smith 1975).

The Abandoned Mine Problem

Early coal mining in Illinois consisted of digging in outcrops along river bluffs or stripping shallow overburden from seams near the surface. Such techniques resulted in very little refuse (waste coal and other debris) at the surface, as most coal was selected by hand without further processing. After 1850, higher profits and greater demand for coal prompted the extension of earlier drift mines and stimulated the opening of many new underground mines, most of which required slope or shaft entrances to reach the deeper coal seams (Andros 1915). Following the indroduction of mechanized mining methods such as cutting machines, which were reported in use in Illinois as early as 1882 (Illinois Department of Mines and Minerals 1954), greater quantities of refuse were brought to the surface. The use of mechanized loaders, introduced in Illinois mines in the early 1900's, also resulted in less selection of coal underground; consequently, more processing on the surface was required. Early mechanized mining produced coal containing approximately eight percent refuse (Coalgate et al. 1973).

Modern mining practices incorporating continuous mining machines as well as the demand for clean, processed coal has resulted in current refuse rates of 20 to 50 percent of the mined coal. In 1974, the nation's coal industry generated about 130 million tons of coal mine refuse (Schlick and Wahler 1976). Refuse produced by underground mines in Illinois totaled an estimated 8 to 15 million tons in 1975, or approximately 8.9 million cubic yards.

Coal preparation plants produce two types of refuse material: gob and slurry. Coarse refuse (plus 28 sieve or $>$0.5 mm size), referred to

as gob, contains waste coal, rock, pyrites, or other materials of relatively large size. The washing process produces effluent (minus 28 sieve size), referred to as slurry, containing small coal particles, clays, and other debris (Martin 1974; Schlick and Wahler 1976). In the past, gob was deposited in refuse piles; slurry was pumped and deposited into streams, onto adjacent terrestrial areas, or into impoundments.

After the abandonment of underground mines, many refuse areas have remained as health, safety, and environmental problems. In addition to being aesthetically offensive, acid drainage, erosion, and sedimentation can drastically affect adjacent terrestrial and aquatic areas. Also, faulty engineering procedures can result in the collapse of refuse embankments as so strikingly exemplified by the 1972 Buffalo Creek disaster which claimed 125 lives in West Virginia (Schlick and Wahler 1976). Furthermore, abandoned buildings, discarded equipment, and unsealed mine entrances located on the tipple area are potentially hazardous and contribute to the environmental problems.

Increased awareness and concern for health, safety, and environmental problems associated with both active and abandoned underground mines have prompted the enactment of both federal and state statutes to monitor, control, and rectify past problems. Two federal statutes administered by the Environmental Protection Agency (EPA) regulate coal mine water pollution. The Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500) and its permit system known as the National Pollutant Discharge Elimination System (NPDES) enforce both technologically-based effluent limitation guidelines and water quality standards (United States Congress 1972). The EPA sets effluent limitations for

specific pollutants; individual states may adopt water quality standards, subject to EPA approval (Begley and Williams 1976).

General water quality standards for Illinois are established by the Illinois Pollution Control Board Regulations, Chapter 3: Water Pollution (Illinois Pollution Control Board 1976). Specific regulations of Chapter 4: Mine Related Pollution insured that environmental considerations are taken into account when planning the location, operation, and abandonment of mining and refuse areas (Illinois Pollution Control Board 1972). The Illinois Environmental Protection Agency is responsible for granting permits, monitoring water quality, and enforcing the standards set forth in these regulations. In addition to establishing environmental guidelines for active mines, specific requirements state that within one year of the cessation of operation, a permit to abandon must be obtained, and refuse piles and slurry ponds must be graded and vegetated in accordance with the grading and revegetation standards of Sections 6206 (a), (f), and (k) of the Illinois Surface-Mined Land Conservation Act of 1971 (Illinois Pollution Control Board 1972).

Prior to the enactment of Chapter 4 of the Illinois Pollution Control Board Regulations, specific environmental legistation did not exist for regulating the abandonment of underground mines. Consequently, many underground mines abandoned prior to 1972 had received little or no reclamation treatment. To deal with these unreclaimed mines (including lands affected by surface mining prior to 1962), the Abandoned Mined Lands Reclamation Act of 1975 empowered the State to acquire abandoned mined lands and to restore them to productive use (Illinois

General Assembly 1975). Acquisition priorities for abandoned mined lands were based upon the following considerations: 1) the extent of air and water pollution, 2) the financial ability of owners to correct pollution problems, 3) potential economic or recreational value of the reclaimed mined land, and 4) associated health or safety problems.

An inventory and assessment of unreclaimed lands and associated environmental problems is recognized as being an integral step in carrying out the directives of the Abandoned Mined Lands Reclamation Act. During 1970 and 1971, The Cooperative Wildlife Research Laboratory of Southern Illinois University at Carbondale conducted an intensive survey of all surface mined lands in Illinois (Klimstra and Terpening 1974; Haynes and Klimstra 1975a, b); however, similar information was lacking for underground mines. Recognizing this need, the Illinois Institute for Environmental Quality (IIEQ) funded the Laboratory in 1975 to conduct a survey of underground mines in Illinois.

As enforcement of current federal and state regulations will prevent environmental problems related to the operation and abandonment of active underground mines, it was the primary emphasis of the survey to inventory all abandoned underground mine sites and to assess the extent of related environmental problems. The specific objectives of the survey were:

1) To locate, determine size, and establish status of each mine site

2) To describe in detail each site including such aspects as gob, slurry, debris, structures, railways, water, shafts, etc.

3) To identify any utilization, reclamation effort, and/or natural rehabilitation

4) To determine the on- and/or off-site problems and delineate the nature of each

5) to establish current ownership.

METHODS AND MATERIALS

Field Survey

Prior to commencement of the statewide survey, a pilot study was conducted to develop research methods and to design field forms. Records of the Illinois Department of Mines and Minerals (Annual Coal Reports from 1883 to 1975, and Mine Inspection Reports), the Illinois State Geological Survey (Mined-Out Coal Maps), and the Illinois Environmental Protection Agency were utilized to locate abandoned underground mine sites. Other sources included city, county, and state historical accounts. Mining company personnel and local residents also contributed useful information in locating abandoned mine sites. Mine site locations were plotted on the appropriate county highway maps and aerial photographs. Current county plat books were used to determine the surface ownership of each mine site.

Field inspections were conducted from 1 October 1975 to 31 August 1976. Following the field inspection of each site, a survey status was assigned which included the following categories: 1) site no longer exists due to surface mining or other development, 2) little or no evidence of past mining activity exists due to revegetation, 3) exact mine site location not found due to insufficient location information, 4) disturbance resulting from mining activity was present, 5) all or part of the abandoned underground mine site currently used by active surface or deep mine to process or store coal, 6) abandoned underground mine site was associated with a surface mine previously inventoried in statewide inventory of surface-mined lands (Haynes and Klimstra 1975a), and 7) permission to survey abandoned mine site denied. To provide a

complete inventory for all deep mines and to enable the inventory to be updated in the future, survey status designations for active mines and mines under construction were included.

Affected acreage at mine sites was divided into the following categories: gob refuse areas, slurry areas, tipple areas, on-site water impoundments, off-site terrestrial areas, and off-site aquatic areas. Affected areas were delineated on appropriate aerial photographs and associated acreages determined at a later date in the laboratory (Figure 2). At each mine site, field survey forms were completed by recording the date of the survey, name of the person conducting the survey, location of the mine site, and remarks concerning the physical and vegetational characteristics of each distinct area at the site (Appendix A).

Physical characteristics recorded for gob, slurry, and tipple areas included affected acreage, drainage, erosion condition, type of past treatment (graded, covered or removed), and present utilization. Height and volume, as well as percent burned, were recorded for gob refuse piles only. Additional characteristics recorded for tipple areas included buildings, mine entrances (open, flooded, and sealed), roads, and associated debris. Physical characteristics recorded for water impoundments included depth, source of pollution (if any), and present utilization. When drainage from a mine site was observed, the source (gob, slurry, mine opening, tipple, or general mine area) and the area affected were recorded. Affected areas included on-site areas, adjacent waterways, off-site terrestrial areas, and off-site aquatic areas.

Evaluation of vegetation occurring on abandoned mine sites included

Figure 2. 1973 aerial photograph illustrating affected areas of an underground coal mine site in Vermilion County abandoned in 1946.

determinations of successional stage, distribution, density, source, and dominant species of ground cover and overstory vegetation. Dominant species and occurrence of emergent, floating, and submergent vegetation were recorded for on-site impoundments. Successional stages of vegetation included the following categories: 1) barren, 2) early invaders, 3) grasses and herbs, 4) herbs, shrubs, and small trees, 5) early forest, and 6) mature forest. However, as the field survey revealed that the early invader stage was composed primarily of grasses and herbs rather than grasses alone, these two successional stages were combined and identified as early invaders. Also, early forest and mature forest were combined into one successional stage identified as forest. Ground cover density was estimated according to the following criteria, modified from Phillips (1959): 1) barren to sparse; covering 10 percent or less of the ground surface, 2) poorly vegetated; ground cover may be numerous but of small cover value, covering 11 to 25 percent of the ground surface, 3) fair to moderately vegetated; covering 26 to 50 percent of the ground surface, 4) good vegetation cover; covering 51 to 75 percent of the ground surface, and 5) excellent vegetation cover; covering more than 75 percent of the ground surface. Estimation of overstory vegetation density was based on three categories: 1) light; covering 10 percent or less of the surface area, 2) moderate; covering from 11 to 75 percent of the surface area, and 3) heavy; covering over 75 percent of the surface area.

Drainage and Refuse Analysis

Mine drainage sampling generally followed rainfall to maximize the possibility of collecting runoff. Drainage samples were taken within a few inches of the surface in plastic bottles previously HCl-washed and rinsed with distilled-deionized water. Bottles were filled to capacity. Water samples were classified into six on-site and four off-site categories as follows:

On-site

1) General runoff from mine area
2) Pools on gob areas
3) Pools on slurry areas
4) Mine opening--flooded
5) Mine opening--flowing
6) Water impoundments (mine ponds)

Off-site

7) Adjacent ditch, stream, creek or river--above mine site
8) Adjacent ditch, stream, creek or river--below mine site
9) Adjacent flooded terrestrial area
10) Adjacent aquatic area (farm pond, lake, etc.).

Specific conductance, pH, acidity, total iron, soluble manganese, aluminum, and sulfate were measured for all water samples. Analyses for acidity, pH, and conductivity were begun immediately after water samples arrived at the laboratory; in no case were EPA (1974) holding times exceeded. Preservation of iron, manganese, aluminum, and sulfate samples for later analyses was begun soon after they arrived at the laboratory. Samples for manganese, iron, and aluminum were preserved according to

EPA (1974) guidelines. Sulfate samples were preserved by adding formalin to yield a 10 percent concentration (Standard Methods 1971). A 140-day storage study indicated iron, manganese, aluminum, and sulfate samples remained stable for at least that long. All samples were analyzed within 140 days of sampling.

The following water analysis methods were used:

1) Acidity--pH 8.2 (EPA 1971) except 8.2 instead of 8.3
2) Aluminum--Aluminon method (Hach 1975)
3) Iron--Ferrozine Method (Hach 1975)
4) Manganese--Periodate Method (Standard Methods 1971)
5) pH--Glass electrode (ASTM 1976)
6) Specific conductance--Standard Methods (1971)
7) Sulfate--Turbidometric Method, modified to 2-minute stir (Hach 1975).

Volumetric glassware and a spectrophotometer were used with all Hach reagents. Samples for pH, conductivity, and acidity were stabilized to 25° C in a water bath before analyses. Iron, manganese, aluminum, and sulfate samples were analyzed at room temperature. Standards were prepared with each batch of samples analyzed by spectrophotometric methods. Results were calculated by linear regression after correction for reagent and sample blanks. Duplicate analyses were made for all sulfate samples. Acidity was determined by electrometric titration using NaOH. The Federal EPA (1974) boiled and oxidized acidity method was not used as it yields net acidity and is time consuming. Terpening et al. (1975) demonstrated using a matched-pair t-test that the two EPA methods did not yield significantly different results for samples high in iron. Acidity data represent total acidity.

Composite refuse samples were collected from the surface 6 inches and classifed as: unburned gob, burned gob, or slurry. Refuse materials were collected by filling an air-tight plastic bag with 10, 50-75g portions of refuse in order to obtain a representive sample of the area. Individual samples were air dried and crushed to pass a 2-mm sieve (Smith et al. 1974). A 1:1 (refuse:water) slurry was prepared (Bower and Wilcox 1965) from a portion of the 2-mm material, and pH was determined using a combination glass electrode (ASTM 1976). Specific conductance (Standard Methods 1971) was measured on the slurry extract (Bower and Wilcox 1965). A portion of the 2-mm material was crushed to pass a 60-mesh sieve, and potential acidity with non-preserved hydrogen peroxide determined (Smith et al. 1974).

Data Analysis

Upon completion of the field survey, information was transferred from the field data forms and laboratory analysis sheets to optical scanner sheets using variable codes shown in Appendices B to G and format specifications shown in Appendix H. Data on the optical scanner sheets were then transferred to magnetic tapes for storage and computer analysis. Computer analysis of data utilized SPSS (Statistical Package for the Social Sciences) programs (Nie et al. 1975). Historical, physical, and vegetational data were summarized and utilized in preparing Preliminary Summary Reports for each of the 70 counties in which deep mining for coal occurred.

RESULTS AND DISCUSSION

Inventory of Underground Mines

On the basis of available records of the Illinois Department of Mines and Minerals; the Illinois Environmental Protection Agency; the Illinois State Geological Survey; city, county, and state historical accounts; and information from mining company personnel and private citizens, 4,076 abandoned underground mines were documented in 70 counties throughout the coal-bearing Pennsylvanian System in Illinois (Figure 3). Additional documents and historical records, many from the late 1800's, identified more than 2,300 mining operations for which site locations were not available. However, these early mines included small, private operations which worked shallow seams and outcrops; consequently, little or no discernible surface disturbance is likely to exist. Although records are not available to document all past mining activity in the state, it is safe to assume that as many as 8,000 (possibly more) underground mines may have existed at one time in Illinois.

In contrast to the period from 1882 to 1920 when approximately 850 deep mines operated each year in Illinois (Illinois Department of Mines and Minerals 1954), there were only 21 active underground mines in operation in 12 counties in 1975, and one new mine opening (Illinois Department of Mines and Minerals 1975) (Figure 4). However, there are currently plans for the development and construction of seven new deep mines in Illinois (personal communication, 11 January 1977, J. Talbott, Illinois Department of Mines and Minerals).

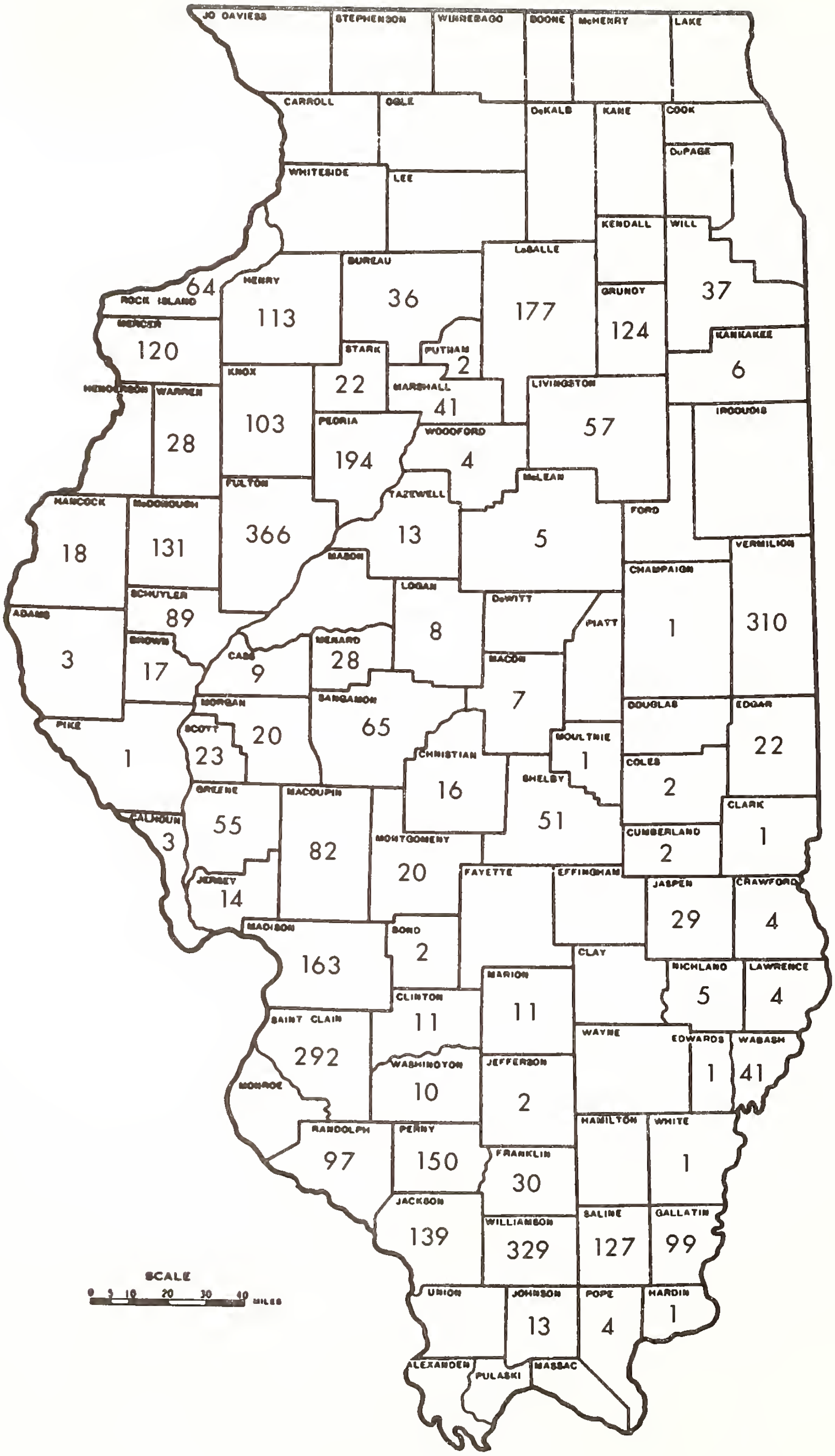

Figure 3. Number of abandoned underground coal mine sites located in Illinois counties as of 1 September 1976.

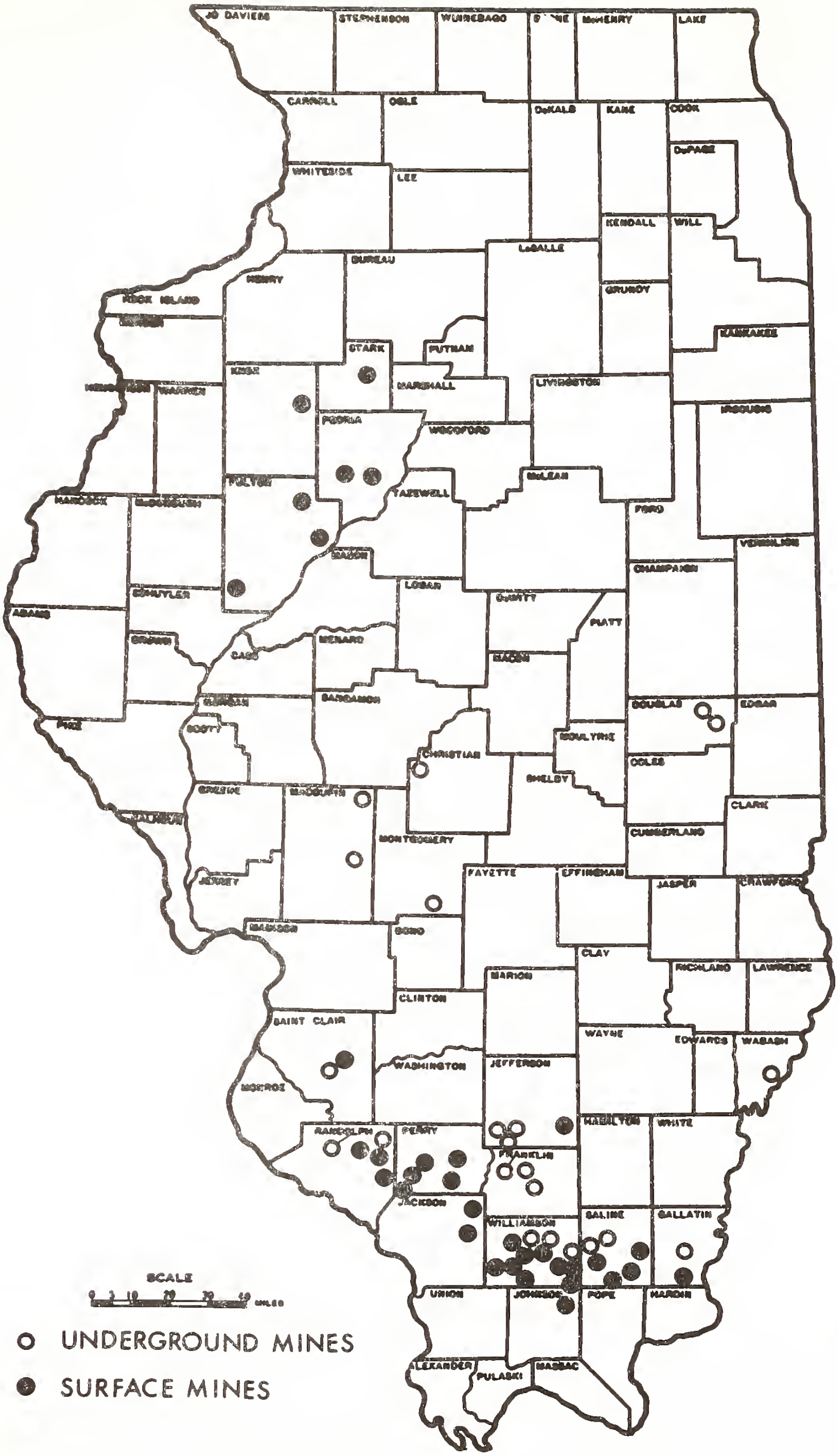

Figure 4. Approximate locations of active underground and surface coal mines in Illinois counties as of 1 September 1976.

Biographic Summary of Underground Mines

Annual reporting by mine operators began in 1882; this information now compiled by the Illinois Department of Mines and Minerals appears in the Annual Coal Report. Data from these reports, although not complete for many of the early mines, were used in preparing a biographic summary for the 4,076 abandoned mines, and the 21 active mines listed in the 1975 Annual Coal Report (Illinois Department of Mines and Minerals 1975).

Abandoned Mines

Of the 4,076 abandoned mines documented, 189 were classified as shipping mines and 808 as local mines (Figures 5 and 6). The remaining 3,079 mines were unclassified, or their classification was unknown. Small drift or slope mining operations characterized the majority of the unclassified mines. These small mining operations were numerous and widespread throughout the regions where shallow seams or outcrops along stream and river banks allowed easy and inexpensive access to the coal. Many of these "dogholes" and "wheelbarrow" mines were operated by private individuals who used the coal either as a source of fuel, or sold it locally for additional income. Illinois Department of Mines and Minerals' mine inspectors reported several hundred private mines operating in their districts during the late 1800's and early 1900's. However, due to their small size and insignificant production, the specific locations and production of these mines were not recorded. Although the majority of the unrecorded mines produced relatively little coal, collectively they represented a significant economic contribution in meeting personal and local fuel needs during the early period of mining in Illinois.

Figure 5. This local mine which operated from 1947 to 1969 supplied coal for local use in Williamson County.

Figure 6. From 1904 to 1938 this shipping class mine worked a 5-foot seam of No. 5 coal at a depth of 413 feet in Saline County.

Available records for 1,620 abandoned underground mines indicated seven seams (seams No. 1 through 7) were mined in Illinois. Fifteen mines reportedly worked more than one seam. Although not documented, many early mines worked locally occurring, commercially insignificant seams. The most extensively mined and economically important seams were No. 5 (Harrisburg-Springfield) and No. 6 (Herrin). Seam No. 6 was mined (540 mines) in 35 counties throughout the state. Seam No. 5 was mined (486 mines) in 23 southeastern, central, and western counties. Mining of Seam No. 7 (Danville) was limited primarily to Vermilion County (161 mines). Seam No. 2 (Colchester) was worked in the early 1900's by 252 mines in the longwall mining region of northern Illinois (Bureau, Grundy, La Salle, Marshall, Will, and Woodford counties). This region of Illinois was the only field in the United States producing a considerable tonnage of coal by the longwall method (Andros 1914). In contrast to the current longwall mining method, early longwall mining worked the coal in an expanding circle from a central block of coal which was left to support the entry shaft and tipple structures. After the shaft pillar had been blocked out, the main haulage way was continued, and work progressed in a long continuous face. Rock and clay refuse materials were used to fill the space from which coal was removed (Andros 1914). Modern longwall mining utilized hydraulic roof supports. Large panels of coal 500 yards or more in length are removed by driving a shearer along the coal face, which may be over 300 feet long. After the coal is removed the shearer and hydraulic supports are advanced and the roof is allowed to collapse (Zabetakis and Phillips 1975). Seam No. 1 (Rock Island) was mined (90 mines) primarily in northern Illinois.

Twelve mines worked Seam No. 3 at depths ranging from 26 feet in Saline County to over 500 feet in La Salle and Putnam counties. Only five mines worked Seam No. 4 (Summum) in four central counties (Edward, Greene, McDonough, and Menard).

Average thickness of seams mined varied from 38 inches for Seam No. 4 to 76 inches for Seam No. 6. The thinnest seam mined was an 18-inch seam of No. 2 coal near Streator in Livingston County. The thickest seams reported to have been mined included a 12-foot seam of No. 6 coal at Carterville in Williamson County, and a 12-foot seam of No. 7 coal at De Soto in Jackson County.

The average depth from surface to coal seam ranged from 80 feet for Seam No. 7 to 181 feet for Seam No. 6. Although Seam No. 1 was worked from shallow depths and outcrops in Rock Island County, a 1,020-foot shaft was used to work the No. 1 and 2 seams at the state's deepest shaft mine in Assumption in Christian County.

Available records for 2,054 abandoned mines identified 1,043 as shaft mines, 700 as slope mines, and 311 as drift mines. Type of opening for the remaining 2,017 mines was not available. The earliest mines, drift mines, worked the shallowest seams at an average depth of 57 feet. Depth from surface to seam averaged 73 feet for slope mines and 180 feet for shafts.

The deepest mines were located in Christian (average depth to seam 599 feet), Franklin (average depth to seam 473 feet), and Jefferson (average depth to seam 792 feet) counties. Fifteen mines worked seams No. 1, 2, 3, and 7 in Greene County at an average depth of only 10 feet. Shallow mines (average depth to seam 18 feet) also worked Seam No. 1

(3 mines) and Seam No. 2 (11 mines) in Scott County. In contrast to the deep shipping class shaft mines of Franklin County where large capital investments were required to mine coal from seams 300 to 700 feet below the surface, the shallow mines of Greene, Scott, and other counties on the border of the coal-bearing Pennsylvanian System represented drift and slope mines typical of the "dog hole" and "wheelbarrow" mines associated with the early period of mining in Illinois.

Active Mines

Fourteen slope and seven shaft mines operated in 12 counties of the state in 1975; 20 mines were shipping mines and 1 was a local mine. Zeigler Coal Company Mine No. 4, which opened in 1943, is the oldest operating underground mine in the state.

Sixteen mines worked the No. 6 coal seam, four mined the No. 5 seam and one mined the No. 7 seam. Depth from the surface to the No. 6 seam ranged from 115 feet at the Peabody Coal Company River King No. 1 Mine in St. Clair County to 800 feet at the Freeman United Coal Mining Corporation No. 3 Mine in Jefferson County. The average thickness of the No. 6 seam was 7.4 feet. The No. 5 seam ranged in depth from 125 feet at the Harrisburg Coal Company Mine in Williamson County to 250 feet at the Peabody Coal Company Eagle No. 2 Mine in Gallatin County. The average thickness of the No. 5 seam was 4.8 feet. AMAX Coal Company Wabash No. 1 Mine was the only underground mine in the state working the No. 7 seam. Depth from surface to seam at this mine ranged from 700 to 1,000 feet with an average seam thickness of 7.5 feet.

Peabody Coal Company Mine No. 10 in Christian County led all

underground mines in production for 1975, producing 4,102,982 tons. Harrisburg Coal Company in Williamson County, the only local class active underground mine in the state, had the lowest production for 1974 (104,248 tons). Total production for all underground mines in 1975 was 31,880,083 tons.

Assessment of Abandoned Underground Mines

Survey Status of Underground Mines

Of 4,076 abandoned underground mines recorded in Illinois, 1,745 (42.8 percent) no longer exist due to other developments (Table 1); a large percentage of abandoned mines recorded in counties where surface mining occurs have been stripped: 59 of 127 (46.5 percent) in Saline County, 94 of 329 (28.6 percent) in Williamson County, 25 of 99 (25.3 percent) in Gallatin County, and 71 of 366 (19.4 percent) in Fulton County. These four counties accounted for 51.7 percent of the 481 abandoned underground mines in the state that no longer exist due to surface mining activities.

Agricultural developments, including row crops, pastures, and animal lots, have converted 606 abandoned mine sites to productive land use (Table 2). Many sites located in counties having fertile soil have been converted to agricultural use: 58 of 113 (51.3 percent) in Henry County, 49 of 120 (40.8 percent) in Mercer County, 34 of 103 (33.0 percent) in Knox County, 21 of 64 (32.8 percent) in Rock Island County, and 40 of 124 (32.3 percent) in Grundy County. One-third of the 606 abandoned mine sites converted to agricultural use occurred in these five counties.

Residential developments accounted for 439 abandoned mine sites that no longer exist (Table 2). Madison, St. Clair, and La Salle counties contained 195 (44.4 percent) of the 439 abandoned mine sites converted to residential use. In Madison County, 71 of 163 (43.6 percent) sites no longer exist due to residential developments. The same is true of 76 of 292 (26.0 percent) sites in St. Clair County and 48 of 177

Table 1. Survey status of 4,076 abandoned underground mines in Illinois counties as of 1 September 1976.

County	Displaced by Other Development	Reverted to a Natural State	Surveyed-Abandoned	Surveyed-Utilized by Active Mine	Associated With Surface Mine[a]	Incomplete Location Information	Total
Adams	2	1	0	0	0	0	3
Bond	0	0	2	0	0	0	2
Brown	5	9	3	0	0	0	17
Bureau	22	4	9	0	0	1	36
Calhoun	1	1	1	0	0	0	3
Cass	2	4	2	0	0	1	9
Champaign	1	0	0	0	0	0	1
Christian	4	2	8	0	0	2	16
Clark	1	0	0	0	0	0	1
Clinton	4	1	6	0	0	0	11
Coles	2	0	0	0	0	0	2
Crawford	2	0	1	0	0	1	4
Cumberland	2	0	0	0	0	0	2
Edgar	10	8	3	0	0	1	22
Edwards	1	0	0	0	0	0	1
Franklin	5	8	17	0	0	0	30
Fulton	138	125	76	0	3	24	366
Gallatin	33	44	14	1	0	7	99
Greene	10	31	2	0	0	12	55
Grundy	73	18	33	0	0	0	124
Hancock	8	7	3	0	0	0	18
Hardin	0	0	0	0	0	1	1
Henry	73	30	10	0	0	0	113
Jackson	44	67	23	0	1	4	139
Jasper	6	17	6	0	0	0	29
Jefferson	1	0	1	0	0	0	2
Jersey	4	8	2	0	0	0	14
Johnson	4	6	2	0	0	1	13

Table 1. Continued.

County	Displaced by Other Development	Reverted to a Natural State	Surveyed-Abandoned	Surveyed-Utilized by Active Mine	Associated With Surface Mine	Incomplete Location Information	Total
Kankakee	3	0	3	0	0	0	6
Knox	51	45	4	0	0	3	103
La Salle	106	41	29	0	0	1	177
Lawrence	1	3	0	0	0	0	4
Livingston	34	13	10	0	0	0	57
Logan	3	2	2	0	0	1	8
Macon	6	1	0	0	0	0	7
Macoupin	13	42	25	0	0	2	82
Madison	108	25	24	0	0	6	163
Marion	4	5	2	0	0	0	11
Marshall	5	15	21	0	0	0	41
McDonough	42	54	29	0	0	6	131
McLean	2	0	3	0	0	0	5
Menard	11	5	10	0	0	2	28
Mercer[b]	72	35	10	0	0	2	120
Montgomery	7	2	8	0	0	3	20
Morgan	8	8	3	0	0	1	20
Moultrie	1	0	0	0	0	0	1
Peoria	101	57	23	0	0	13	194
Perry	71	41	26	1	0	11	150
Pike	0	1	0	0	0	0	1
Pope	3	1	0	0	0	0	4
Putnam	0	0	2	0	0	0	2
Randolph	38	37	15	0	0	7	97
Richland	0	5	0	0	0	0	5
Rock Island	37	22	5	0	0	0	64
Saline	87	10	22	2	3	3	127
Sangamon	26	18	16	0	0	5	65
Schuyler	30	41	16	0	1	1	89
Scott	4	4	4	0	0	11	23
Shelby	22	27	1	0	0	1	51

Table 1. Continued.

County	Displaced by Other Development	Reverted to a Natural State	Surveyed-Abandoned	Surveyed-Utilized by Active Mine	Associated With Surface Mine	Incomplete Location Information	Total
Stark	13	5	4	0	0	0	22
St. Clair	129	74	37	0	1	51	292
Tazewell	3	4	4	0	0	2	13
Vermilion	65	208	31	0	2	4	310
Wabash	28	12	0	0	0	1	41
Warren	17	10	1	0	0	0	28
Washington	4	0	4	0	0	2	10
White	0	0	1	0	0	0	1
Will	9	12	16	0	0	0	37
Williamson	122	85	73	0	4	45	329
Woodford	1	0	3	0	0	0	4
State Total	1,745	1,361	711	4	15	239	4,076

[a] The abandoned mine site was associated with a surface mine previously inventoried in the statewide survey of surface-mined lands (Haynes and Klimstra 1975).

[b] Access was denied to one mine site in Mercer County.

Table 2. Developments which have displaced abandoned underground mine sites in Illinois counties as of 1 September 1976.

County	Surface Mine	Agricultural	Residential	Industrial	Landfill or Dump	Highway	Recreational	Miscellaneous	Total
Adams	1	1	0	0	0	0	0	0	2
Brown	0	4	0	0	0	0	0	1	5
Bureau	18	3	1	0	0	0	0	0	22
Calhoun	0	0	1	0	0	0	0	0	1
Cass	0	0	2	0	0	0	0	0	2
Champaign	0	0	0	1	0	0	0	0	1
Christian	0	1	0	3	0	0	0	0	4
Clark	1	0	0	0	0	0	0	0	1
Clinton	0	1	0	0	1	0	1	1	4
Coles	0	1	0	1	0	0	0	0	2
Crawford	2	0	0	0	0	0	0	0	2
Cumberland	0	2	0	0	0	0	0	0	2
Edgar	0	9	1	0	0	0	0	0	10
Edwards	0	1	0	0	0	0	0	0	1
Franklin	0	2	0	2	1	0	0	0	5
Fulton	71	39	18	5	0	0	5	0	138
Gallatin	25	3	3	0	0	2	0	0	33
Greene	2	7	1	0	0	0	0	0	10
Grundy	12	40	13	8	0	0	0	0	73
Hancock	0	8	0	0	0	0	0	0	8
Henry	1	58	10	1	0	1	2	0	73
Jackson	17	18	5	1	3	0	0	0	44
Jasper	0	4	2	0	0	0	0	0	6
Jefferson	0	0	0	0	0	1	0	0	1
Jersey	0	3	1	0	0	0	0	0	4
Johnson	2	0	1	0	0	1	0	0	4
Kankakee	2	1	0	0	0	0	0	0	3
Knox	13	34	3	0	1	0	0	0	51
La Salle	7	30	48	18	1	0	2	0	106

Table 2. Continued.

County	Surface Mine	Agricultural	Residential	Industrial	Landfill or Dump	Highway	Recreational	Miscellaneous	Total
Lawrence	0	1	0	0	0	0	0	0	1
Livingston	0	5	18	9	0	0	2	0	34
Logan	0	1	2	0	0	0	0	0	3
Macon	0	1	3	2	0	0	0	0	6
Macoupin	0	5	1	7	0	0	0	0	13
Madison	0	23	71	9	0	3	2	0	108
Marion	0	1	0	3	0	0	0	0	4
Marshall	0	2	3	0	0	0	0	0	5
McDonough	0	26	9	1	1	0	1	4	42
McLean	0	0	0	2	0	0	0	0	2
Menard	0	6	4	1	0	0	0	0	11
Mercer	0	49	12	8	3	0	0	0	72
Montgomery	0	7	0	0	0	0	0	0	7
Morgan	0	4	3	1	0	0	0	0	8
Moultrie	0	0	0	0	0	0	0	1	1
Peoria	31	38	22	6	1	3	0	0	101
Perry	21	17	19	6	0	0	0	8	71
Pope	2	1	0	0	0	0	0	0	3
Randolph	17	12	4	0	0	0	0	5	38
Rock Island	0	21	12	2	0	0	2	0	37
Saline	59	12	6	8	0	0	0	2	87
Sangamon	0	6	17	3	0	0	0	0	26
Schuyler	18	9	3	0	0	0	0	0	30
Scott	0	3	0	1	0	0	0	0	4
Shelby	0	12	5	1	0	0	4	0	22
Stark	8	4	1	0	0	0	0	0	13
St. Clair	18	18	76	3	0	4	4	6	129
Tazewell	0	0	1	2	0	0	0	0	3
Vermilion	36	4	20	2	0	3	0	0	65
Wabash	0	23	4	0	0	1	0	0	28
Warren	0	16	1	0	0	0	0	0	17
Washington	0	2	1	1	0	0	0	0	4

Table 2. Continued.

County	Surface Mine	Agricul-tural	Residen-tial	Indus-trial	Landfill or Dump	Highway	Recrea-tional	Miscel-laneous	Total
Will	3	2	1	2	0	0	1	0	9
Williamson	94	5	9	6	5	0	0	3	122
Woodford	0	0	1	0	0	0	0	0	1
State total	481	606	439	126	17	19	26	31	1,745
Percent of total	27.6	34.7	25.2	7.2	1.0	1.1	1.5	1.8	

(27.1 percent) in La Salle County. A complete listing by county of developments which have displaced abandoned mine sites appears in Table 2.

Over one-third (1,361 sites) of the 4,076 abandoned underground mines in the state had reverted to a natural condition with little or no evidence of past mining activities (Figure 7). A large number of these mines were small-scale, seasonal operations termed "gopher hole," "dog hole," or "wheelbarrow" mines which operated at an early date (1880-1915) and produced little surface disturbance.

Specific location information for 239 mines (5.9 percent of the total 4,076) was unavailable; however, most of these mines were small operations that had probably reverted to a natural condition as no evidence of past mining activity or associated pollution was observed in the surrounding area. Therefore, it seems appropriate to assume that mines not located did not constitute environmental problems.

Evidence of past mining existed at 711 (17.4 percent) abandoned mine sites (Table 1). Seven hundred of these sites exhibited all or part of the following: 1) gob refuse areas, 2) slurry refuse areas, 3) tipple areas, 4) water impoundments, 5) open and/or flowing shafts, and 6) adjacent disturbed terrestrial or aquatic areas (Figure 8). Eleven sites consisted of only tipple foundations or debris, or hazardous or flowing openings with no associated affected acreage.

All or part of four abandoned mine sites were being utilized by active strip or underground mine operations for processing or storage of coal. Disturbed acreage at 15 abandoned mine sites had been included in the state surface-mine survey (Haynes and Klimstra 1975a) and the

Figure 7. Little evidence of mining activity remains at this revegetated mine site in Williamson County which was abandoned in 1939.

Figure 8. Disturbance associated with past mining, including 34 acres of barren gob, tipple, and affected terrestrial areas, were present at this deep-mine site in Macoupin County abandoned in 1952.

surface-mine problem site inventory and assessment (Klimstra and Terpening 1974) and was not repeated in the data summary of the present survey. Access to one mine site was denied by the landowner; however, observation of aerial photographs revealed no discernible surface disturbance.

Acreage Affected by Abandoned Underground Mines

Disturbance from past mining activity totaling 6,955.9 acres was present at 700 abandoned mine sites in 55 counties throughout the state (Figure 9, Table 3). Surface disturbance at individual mine sites varied from 0.1 to 351.4 acres. Affected acreage included gob (3,943.5 acres), slurry (693.8 acres), tipple (813.2 acres), water impoundments (647.7 acres), and off-site affected areas (857.7 acres) (Figure 10). Disturbed land was unequally distributed among the 55 counties; 11 counties (20.0 percent) accounted for 5,622.9 (80.8 percent) of the affected acres with an average of 21.4 acres for 263 mine sites. The 11 counties included Franklin (1,517.8 acres), Williamson (800.9 acres), Christian (609.7 acres), Macoupin (518.2 acres), Saline (497.8 acres), Perry (398.0 acres), St. Clair (311.0 acres), Madison (273.5 acres), Randolph (266.3 acres), Montgomery (226.9 acres), and Bureau (202.8 acres) (Table 3). In contrast, the remaining 44 counties (80.0 percent of the 55 counties) accounted for only 1,330.0 disturbed acres (19.2 percent) with an average of 3.0 disturbed acres for 437 mine sites.

Affected Acreage by Mine Operator-- Underground mine operators ranged from private individuals who mined small quantities of coal for personal use to the present day corporate mines which produce in excess

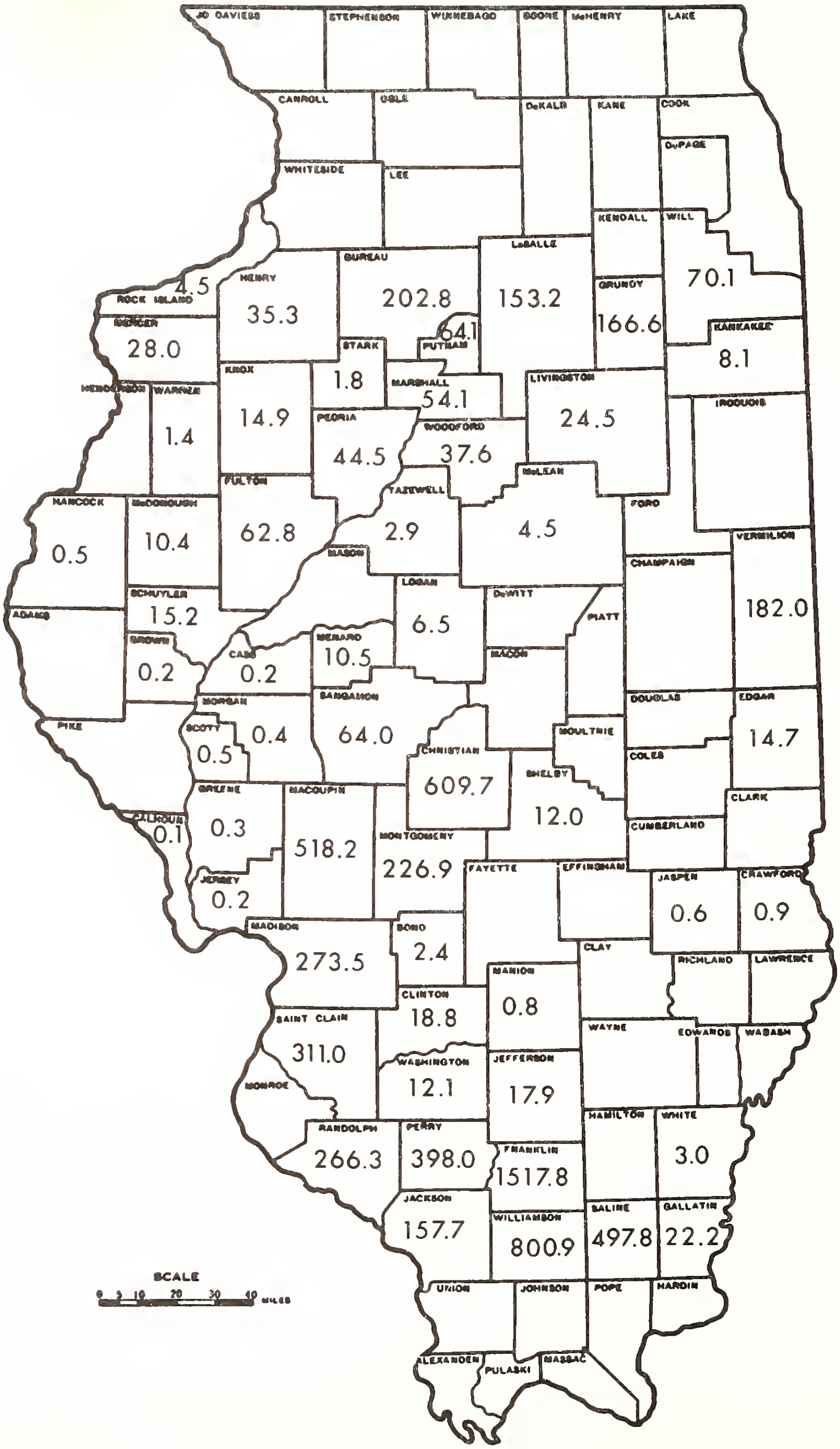

Figure 9. Acreage affected by abandoned underground coal mines in Illinois counties as of 1 September 1976.

Table 3. Acreage affected by abandoned underground coal mines in Illinois counties as of 1 September 1976.

County	Number Mines	Total Acreage	Gob	Slurry	Tipple	Impound-ments	Off-site Terrestrial	Off-site Aquatic
Bond	2	2.4	0.7	0.0	1.4	0.3	0.0	0.0
Brown	2	0.2	0.2	0.0	0.0	0.0	0.0	0.0
Bureau	9	202.8	142.7	0.0	13.1	1.8	43.0	2.2
Calhoun	1	0.1	0.1	0.0	0.0	0.0	0.0	0.0
Cass	2	0.2	0.2	0.0	0.0	0.0	0.0	0.0
Christian	8	609.7	519.9	0.0	3.9	84.5	1.4	0.0
Clinton	6	18.8	15.3	0.0	3.5	0.0	0.0	0.0
Crawford	1	0.9	0.2	0.0	0.0	0.0	0.7	0.0
Edgar	3	14.7	6.0	0.0	1.7	0.0	7.0	0.0
Franklin	17	1,517.8	627.2	244.9	246.1	148.6	250.0	1.0
Fulton	75	62.8	42.2	0.0	19.0	0.1	1.3	0.2
Gallatin	11	22.2	17.0	0.0	2.6	1.0	1.6	0.0
Greene	2	0.3	0.3	0.0	0.0	0.0	0.0	0.0
Grundy	33	166.6	124.1	36.7	1.6	4.2	0.0	0.0
Hancock	3	0.5	0.5	0.0	0.0	0.0	0.0	0.0
Henry	10	35.3	22.8	0.0	11.1	1.1	0.3	0.0
Jackson	20	157.7	109.8	8.2	13.9	11.8	14.0	0.0
Jasper	6	0.6	0.6	0.0	0.0	0.0	0.0	0.0
Jefferson	1	17.9	0.0	0.0	16.9	1.0	0.0	0.0
Jersey	2	0.2	0.2	0.0	0.0	0.0	0.0	0.0
Kankakee	3	8.1	6.6	0.0	0.0	0.0	1.5	0.0
Knox	4	14.9	9.6	0.0	2.3	0.0	0.0	3.0
La Salle	29	153.2	131.4	0.0	6.6	3.4	11.8	0.0
Livingston	10	24.5	15.2	0.0	2.7	0.1	4.1	2.4
Logan	2	6.5	4.2	0.0	2.3	0.0	0.0	0.0
Macoupin	25	518.2	191.1	22.1	54.4	96.4	149.0	5.2
Madison	24	273.5	155.1	25.5	14.3	24.1	54.0	0.5
Marion	2	0.8	0.8	0.0	0.0	0.0	0.0	0.0
Marshall	21	54.1	49.6	0.0	0.0	0.0	2.5	2.0
McDonough	29	10.4	9.8	0.0	0.5	0.0	0.0	0.1

Table 3. Continued.

County	Number Mines	Total Acreage	Gob	Slurry	Tipple	Impound-ments	Off-site Terrestrial	Off-site Aquatic
McLean	3	4.5	4.5	0.0	0.0	0.0	0.0	0.0
Menard	10	10.5	5.3	0.0	1.9	0.0	3.3	0.0
Mercer	10	28.0	21.3	0.0	5.7	1.0	0.0	0.0
Montgomery	8	226.9	134.8	0.0	52.7	34.7	4.7	0.0
Morgan	3	0.4	0.4	0.0	0.0	0.0	0.0	0.0
Peoria	23	44.5	30.9	0.0	13.5	0.1	0.0	0.0
Perry	26	398.0	157.7	76.5	45.9	24.2	82.6	11.1
Putnam	2	64.1	56.6	0.0	7.5	0.0	0.0	0.0
Randolph	14	266.3	108.2	67.1	19.8	56.4	14.8	0.0
Rock Island	5	4.5	4.3	0.0	0.2	0.0	0.0	0.0
Saline	22	497.8	359.0	0.0	82.6	39.6	16.6	0.0
Sangamon	16	64.0	56.4	0.0	3.2	4.4	0.0	0.0
Schuyler	16	15.2	14.2	0.0	1.0	0.0	0.0	0.0
Scott	4	0.5	0.5	0.0	0.0	0.0	0.0	0.0
Shelby	1	12.0	2.6	1.1	0.0	0.6	7.7	0.0
Stark	4	1.8	1.7	0.0	0.0	0.0	0.0	0.1
St. Clair	37	311.0	187.2	81.5	28.5	9.8	4.0	0.0
Tazewell	4	2.9	2.4	0.0	0.5	0.0	0.0	0.0
Vermilion	31	182.0	152.7	10.5	18.4	0.0	0.0	0.4
Warren	1	1.4	0.0	0.0	0.0	0.0	1.4	0.0
Washington	4	12.1	4.6	3.5	3.5	0.5	0.0	0.0
White	1	3.0	3.0	0.0	0.0	0.0	0.0	0.0
Will	16	70.1	50.2	15.2	3.3	0.0	0.0	1.4
Williamson	73	800.9	355.0	101.0	103.0	96.9	138.7	6.3
Woodford	3	37.6	26.6	0.0	4.1	1.1	5.5	0.3
State	700	6,955.9	3,943.5	693.8	813.2	647.7	821.5	36.2

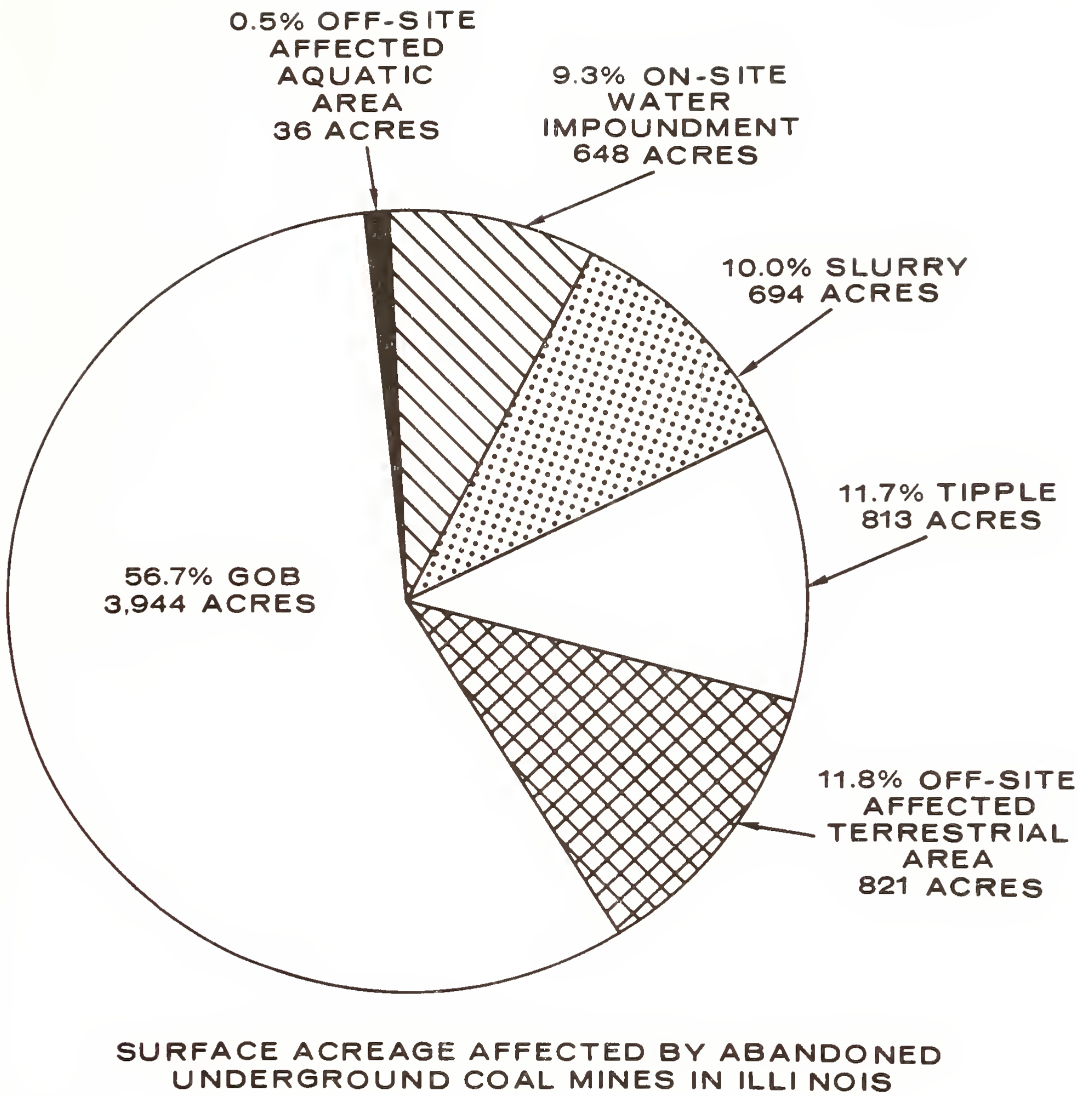

Figure 10. Affected acreage of on- and off-site areas associated with abandoned underground coal mines in Illinois as of 1 September 1976.

of 4 million tons per year. Major mining companies represent large corporate operations which operated from 1 to 20 large mines (Appendix E). Mines operated by major mining companies were usually shipping class mines. Private individuals or small mining companies operated small, usually local class mines owned by individuals or partnerships. Miscellaneous operators included companies which mined coal for their own use. Two such companies were the Hegeler Zinc Company, which operated a shaft mine in Vermilion County to supply coal for a zinc processing plant, and the Streator Clay Manufacturing Company, which mined coal in La Salle County for use in clay tile manufacturing. Mines worked by unknown operators included small drift mines which worked exposed coal seams along stream banks.

Individuals or small mining companies were responsible for the operation of 2,743 (67.3 percent) of the total 4,076 mines recorded; major mining companies for 398 (9.8 percent), unknown operators for 917 (22.5 percent), and miscellaneous companies for 18 (0.4 percent)(Tables 4 and 5). Only 16.5 percent of the mine sites operated by individuals or small companies and 7.9 percent of the mine sites where the operator was unknown still exist. In contrast to mines worked by small or unknown operators, 43.2 percent of the mines operated by major mining companies still exist (Table 5).

Of the total affected acreage, only 26.1 percent (1,812.8 acres) resulted from mines operated by individuals or small companies. Although less than one-fourth of the 700 existing abandoned mine sites had been operated by major mining companies, almost three-fourths of the

Table 4. Number of mines and affected acreage per mine operator for underground coal mines in Illinois counties as of 1 September 1976.

County	Unknown		Individuals or Small Companies		Major Mining Companies		Miscellaneous Companies		Total	
	#	acres	#	acres	#	acres	#	acres	#	acres
Bond	0	0.0	2	2.4	0	0.0	0	0.0	2	2.4
Brown	0	0.0	2	0.2	0	0.0	0	0.0	2	0.2
Bureau	0	0.0	1	0.1	8	202.7	0	0.0	9	202.8
Calhoun	0	0.0	1	0.1	0	0.0	0	0.0	1	0.1
Cass	0	0.0	2	0.2	0	0.0	0	0.0	2	0.2
Christian	0	0.0	3	18.8	5	590.9	0	0.0	8	609.7
Clinton	0	0.0	1	6.8	5	12.0	0	0.0	6	18.8
Crawford	0	0.0	1	0.9	0	0.0	0	0.0	1	0.9
Edgar	0	0.0	3	14.7	0	0.0	0	0.0	3	14.7
Franklin	0	0.0	1	8.0	16	1,509.8	0	0.0	17	1,517.8
Fulton	17	3.5	54	43.5	4	15.8	0	0.0	75	62.8
Gallatin	2	4.0	9	18.2	0	0.0	0	0.0	11	22.2
Greene	0	0.0	2	0.3	0	0.0	0	0.0	2	0.3
Grundy	0	0.0	12	17.1	21	149.5	0	0.0	33	166.6
Hancock	1	0.1	2	0.4	0	0.0	0	0.0	3	0.5
Henry	3	1.0	7	34.3	0	0.0	0	0.0	10	35.3
Jackson	0	0.0	17	144.9	3	12.8	0	0.0	20	157.7
Jasper	0	0.0	6	0.6	0	0.0	0	0.0	6	0.6
Jefferson	0	0.0	0	0.0	1	17.9	0	0.0	1	17.9
Jersey	0	0.0	2	0.2	0	0.0	0	0.0	2	0.2
Kankakee	0	0.0	3	8.1	0	0.0	0	0.0	3	8.1
Knox	1	0.1	3	14.8	0	0.0	0	0.0	4	14.9
La Salle	4	20.9	11	41.1	13	90.4	1	0.8	29	153.2
Livingston	3	5.2	5	13.1	1	2.5	1	3.7	10	24.5
Logan	0	0.0	2	6.5	0	0.0	0	0.0	2	6.5
Macoupin	2	66.2	13	112.4	10	339.6	0	0.0	25	518.2
Madison	0	0.0	21	264.8	3	8.7	0	0.0	24	273.5
Marion	0	0.0	2	0.8	0	0.0	0	0.0	2	0.8

Table 4. Continued.

County	Unknown		Individuals or Small Companies		Major Mining Companies		Miscellaneous Companies		Total	
	#	acres	#	acres	#	acres	#	acres	#	acres
Marshall	4	2.6	12	4.6	5	46.9	0	0.0	21	54.1
McDonough	10	4.4	19	6.0	0	0.0	0	0.0	29	10.4
McLean	0	0.0	3	4.5	0	0.0	0	0.0	3	4.5
Menard	0	0.0	10	10.5	0	0.0	0	0.0	10	10.5
Mercer	3	0.3	3	8.1	4	19.6	0	0.0	10	28.0
Montgomery	0	0.0	3	15.8	5	211.1	0	0.0	8	226.9
Morgan	0	0.0	3	0.4	0	0.0	0	0.0	3	0.4
Peoria	1	0.1	18	32.8	4	11.6	0	0.0	23	44.5
Perry	3	23.9	19	77.3	4	296.8	0	0.0	26	398.0
Putnam	0	0.0	2	64.1	0	0.0	0	0.0	2	64.1
Randolph	3	1.6	9	256.0	1	0.9	1	7.8	14	266.3
Rock Island	2	0.2	2	4.0	1	0.3	0	0.0	5	4.5
Saline	0	0.0	12	59.9	10	437.9	0	0.0	22	497.8
Sangamon	0	0.0	9	26.8	7	37.2	0	0.0	16	64.0
Schuyler	5	1.6	11	13.6	0	0.0	0	0.0	16	15.2
Scott	0	0.0	4	0.5	0	0.0	0	0.0	4	0.5
Shelby	0	0.0	1	12.0	0	0.0	0	0.0	1	12.0
Stark	1	0.1	3	1.7	0	0.0	0	0.0	4	1.8
St. Clair	2	10.1	29	71.6	5	228.3	1	1.0	37	311.0
Tazewell	1	0.9	3	2.0	0	0.0	0	0.0	4	2.9
Vermilion	2	1.3	23	49.0	6	131.7	0	0.0	31	182.0
Warren	1	1.4	0	0.0	0	0.0	0	0.0	1	1.4
Washington	0	0.0	4	12.1	0	0.0	0	0.0	4	12.1
White	0	0.0	1	3.0	0	0.0	0	0.0	1	3.0
Will	0	0.0	7	13.5	9	56.6	0	0.0	16	70.1
Williamson	1	0.3	51	252.1	21	548.5	0	0.0	73	800.9
Woodford	0	0.0	3	37.6	0	0.0	0	0.0	3	37.6
State	72	149.8	452	1,812.8	172	4,980.0	4	13.3	700	6,955.9

Table 5. Total recorded abandoned underground mines and abandoned mines with affected acreages by type of mine operator in Illinois as of 1 September 1976.

	Total Abandoned Mines Recorded		Existing Abandoned Mines With Affected Acreage			Affected Acreage		
	#	%	#	% of Mines Recorded	% of Mines in Existence	Acres	Average Acreage	% of Affected Acreage
Individuals or Small Companies	2,743	67.3	452	16.5	64.6	1,812.8	4.0	26.1
Major Mining Companies	398	9.8	172	43.2	24.6	4,980.0	29.0	71.6
Unknown Operators	917	22.5	72	7.9	10.3	149.8	2.1	2.2
Miscellaneous Companies	18	0.4	4	22.2	0.6	13.3	3.3	0.2
Total	4,076		700			6,955.9		

affected land (4,980.0 acres) was associated with these operators. The reason is apparent when the average size of existing abandoned mine sites is considered: 29.0 acres for major mining companies (172 sites), 4.0 acres for individuals or small companies (452 sites), 3.3 acres for miscellaneous companies (4 sites), and 2.1 acres for unknown operators (72 sites) (Table 5). More refuse and land disturbance was associated with the larger mines, as major mining companies were able to invest capital in above-ground washing and separating facilities, while smaller operators separated refuse from coal underground.

Large abandoned mine sites associated with major mining companies represented a greater environmental threat than those mines worked by smaller operators. Therefore, state reclamation efforts should focus on the large sites. In addition, many of the small mine sites can be expected to revert to a natural state or be converted to other developments by the landowner, as has occurred in the past. Intensified land development may greatly accelerate the elimination of disturbance associated with small mine sites, particularly in urban areas.

Affected Acreage by Environmental Locale-- Environmental locale was designated as the present land use of areas surrounding abandoned mine sites. Rural locales were divided into five categories including agricultural areas (pastures and cropland), rural residential areas (small groups of houses located in rural settings and adjacent to, or surrounding abandoned mine sites), old field areas (land not in productive use), forested areas, and land which had been surface mined. Urban locales were designated as residential or industrial. Miscellaneous locales included parks, highways, golf courses, and lakes. Of the

4,076 abandoned mines in the state, 1,147 were in agricultural locales, 262 were in rural residential locales, 78 in old field locales, 1,250 in forested areas, 564 in surface-mined areas, 431 in urban residential locales, 144 in urban industrial locales, and 32 in miscellaneous locales.

Of the 700 mines with affected acreages, 281 were located in agricultural locales which encompassed over one-half (3,776.6 acres) of the total affected acreage in the state. Fifty-five mine sites (538.3 acres) were present in rural residential settings. Twenty-three sites (142.8 acres) were situated in old fields, and 221 mine sites (1,197.6 acres) were located in forested areas. Although surface mining has eliminated more than 400 underground mine sites, 17 mines (82.8 acres) remained in surface-mined locales. Urban areas encompassed 102 mine sites; 28 (288.2 acres) in urban industrial; and 74 (924.6 acres) in urban residential settings (Table 6).

The impact of environmental problems related to abandoned mines differs in magnitude with the environmental locale of a given mine. Those abandoned mines situated in urban environments are aesthetically displeasing to more people than mines located in rural areas removed from highways and residential developments. Air pollution resulting from burning refuse piles or particulate matter introduced into the atmosphere by high winds blowing across large refuse areas can be a problem in residential areas. Siltation of drainage ditches by gob and slurry refuse may cause flooding in residential areas, requiring an expenditure of time and money for dredging. Drainage and siltation into adjacent fields in agricultural areas forces farmers to construct small levees and ditches around abandoned refuse sites. Drainage from

Table 6. Acreage per environmental locale of land affected by abandoned underground coal mines in Illinois counties as of 1 September 1976

County	Environmental Locale								
	Urban Residential	Urban Industrial	Rural Residential	Agricultural	Old Field	Forest	Surface Mine	Other	Total
Bond	0.0	2.0	0.0	0.4	0.0	0.0	0.0	0.0	2.4
Brown	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.2
Bureau	81.6	54.4	21.2	24.3	0.0	21.3	0.0	0.0	202.8
Calhoun	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1
Cass	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.2
Christian	4.7	12.4	0.0	592.6	0.0	0.0	0.0	0.0	609.7
Clinton	0.0	2.3	0.0	14.6	0.0	1.9	0.0	0.0	18.8
Crawford	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.9
Edgar	0.0	0.0	0.0	12.5	0.0	2.2	0.0	0.0	14.7
Franklin	364.5	62.7	179.4	430.9	0.0	480.3	0.0	0.0	1,517.8
Fulton	0.0	3.4	0.8	43.6	3.7	8.7	2.6	0.0	62.8
Gallatin	0.0	0.0	7.4	0.0	0.0	14.5	0.3	0.0	22.2
Greene	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.3
Grundy	21.8	2.3	1.2	124.0	0.0	17.3	0.0	0.0	166.6
Hancock	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.5
Henry	0.0	0.0	6.0	28.9	0.0	0.4	0.0	0.0	35.3
Jackson	0.2	0.0	4.5	119.9	0.0	31.0	1.2	0.0	157.7
Jasper	0.0	0.0	0.0	0.2	0.0	0.4	0.0	0.0	0.6
Jefferson	0.0	0.0	0.0	17.9	0.0	0.0	0.0	0.0	17.9
Jersey	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.2
Kankakee	0.0	0.0	0.0	8.1	0.0	0.0	0.0	0.0	8.1
Knox	0.0	0.0	0.0	10.9	0.0	4.0	0.0	0.0	14.9
La Salle	18.4	29.4	0.5	74.9	5.9	24.1	0.0	0.0	153.2
Livingston	4.4	3.7	0.0	16.4	0.0	0.0	0.0	0.0	24.5
Logan	0.0	3.4	0.0	3.1	0.0	0.0	0.0	0.0	6.5
Macoupin	177.4	0.0	143.4	197.1	0.0	0.3	0.0	0.0	518.2
Madison	6.8	2.9	8.4	250.2	0.2	0.0	0.0	5.0	273.5

Table 6. Continued

County	Environmental Locale: Urban Residen-tial	Urban Indus-trial	Rural Residen-tial	Agricul-tural	Old Field	Forest	Surface Mine	Other	Total
Marion	0.0	0.3	0.0	0.5	0.0	0.0	0.0	0.0	0.8
Marshall	11.1	20.1	1.4	17.5	0.0	4.0	0.0	0.1	54.1
McDonough	1.1	0.0	0.0	6.2	0.0	3.1	0.0	0.0	10.4
McLean	2.5	2.0	0.0	0.0	0.0	0.0	0.0	0.0	4.5
Menard	0.0	0.1	1.4	8.8	0.0	0.2	0.0	0.0	10.5
Mercer	0.0	0.0	0.0	27.9	0.0	0.1	0.0	0.0	28.0
Montgomery	69.7	0.9	0.0	146.9	3.3	6.1	0.0	0.0	226.9
Morgan	0.0	0.0	0.0	0.2	0.0	0.0	0.2	0.0	0.4
Peoria	0.0	0.0	3.0	9.7	0.0	31.8	0.0	0.0	44.5
Perry	17.4	0.0	6.9	323.0	12.4	23.2	15.1	0.0	398.0
Putnam	64.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	64.1
Randolph	0.0	7.8	3.5	248.7	0.0	6.3	0.0	0.0	266.3
Rock Island	0.0	0.0	0.3	3.9	0.0	0.3	0.0	0.0	4.5
Saline	5.0	10.0	55.2	282.1	96.7	3.4	45.4	0.0	497.8
Sangamon	19.6	22.2	1.2	21.0	0.0	0.0	0.0	0.0	64.0
Schuyler	0.0	0.0	1.3	5.6	0.4	7.9	0.0	0.0	15.2
Scott	0.0	0.0	0.0	0.2	0.0	0.3	0.0	0.0	0.5
Shelby	0.0	0.0	0.0	12.0	0.0	0.0	0.0	0.0	12.0
Stark	0.0	0.0	0.0	0.1	0.0	1.7	0.0	0.0	1.8
St. Clair	18.5	0.5	5.7	273.1	1.3	11.9	0.0	0.0	311.0
Tazewell	0.9	0.0	0.0	0.0	0.0	2.0	0.0	0.0	2.9
Vermilion	10.1	2.5	1.1	144.8	0.0	23.5	0.0	0.0	182.0
Warren	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	1.4
Washington	0.0	0.0	0.0	7.0	0.4	4.7	0.0	0.0	12.1
White	0.0	0.0	0.0	0.0	0.0	3.0	0.0	0.0	3.0
Will	4.0	0.0	0.2	54.6	4.6	6.7	0.0	0.0	70.1
Williamson	13.9	31.2	84.2	190.8	13.9	448.9	18.0	0.0	800.9
Woodford	6.9	11.7	0.0	19.0	0.0	0.0	0.0	0.0	37.6
State	924.6	288.2	538.3	3,776.6	142.8	1,197.6	82.8	5.0	6,955.9

abandoned underground workings destroyed forest vegetation in the Shawnee National Forest of southern Illinois. Decisions regarding the priority of mines to be reclaimed should consider all of the environmental and aesthetic problems as they relate to the locale of individual mines.

Ownership of Affected Areas-- Of the 700 mines with affected acreage, 564 sites were owned by private individuals. These sites affected 3,507.5 acres, over one-half of the affected acreage in the state, and averaged 6.2 acres per mine site (Table 7). In comparison, mining companies owned only 49 abandoned mine sites with associated land disturbance; but, these sites accounted for 2,318.5 affected acres and averaged 47.3 acres per mine site. Bank and trust companies owned eight mine sites affecting 370.7 acres and averaging 46.3 acres per site. Federal, state, county, and city governments owned 34 sites affecting 250.5 acres. Miscellaneous groups owned 41 sites affecting 436.4 acres (Table 7).

Generally, the present owner (when private) was not the operator of the abandoned mine, but acquired the abandoned site with the purchase of a large tract of land. Although present owners may legally be responsible for associated pollution problems, many private owners are not financially able to correct the problems. Consequently, ownership and financial capability should be considered in establishing priorities of a state-sponsored pollution abatement program for abandoned mine sites.

Gob - Physical Characteristics

Barren refuse banks have long been considered an unfortunate but unavoidable consequence of coal mining. Abandoned coal refuse piles in

Table 7. Affected acreage per owner of abandoned underground coal mines in Illinois counties as of 1 September 1976.

County	Unknown & Other	Private	Federal	State	County & City	Recreational Assoc.	Mining Company	Utility Company	Farm Corp.	Bank & Trust	Misc. Company	Total
Bond	0.0	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4
Brown	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Bureau	0.0	70.5	0.0	0.0	132.3	0.0	0.0	0.0	0.0	0.0	0.0	202.8
Calhoun	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Cass	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Christian	0.0	17.1	0.0	0.0	10.8	0.0	581.8	0.0	0.0	0.0	0.0	609.7
Clinton	0.0	18.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.8
Crawford	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9
Edgar	0.0	14.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.7
Franklin	0.0	323.9	0.0	0.0	0.0	0.0	841.0	0.0	34.9	261.2	56.8	1,517.8
Fulton	0.0	52.5	0.0	0.0	4.8	0.5	4.6	0.3	0.1	0.0	0.0	62.8
Gallatin	0.0	20.1	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.2
Greene	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
Grundy	0.0	164.0	0.0	0.0	0.0	2.6	0.0	0.0	0.0	0.0	0.0	166.6
Hancock	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
Henry	0.0	35.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	35.3
Jackson	0.0	155.6	0.0	0.0	0.2	0.0	1.8	0.0	0.1	0.0	0.0	157.7
Jasper	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6
Jefferson	0.0	17.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.9
Jersey	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Kankakee	0.0	5.6	0.0	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0	8.1
Knox	0.0	13.9	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	14.9
La Salle	0.0	129.8	0.0	14.1	0.0	0.0	0.0	0.0	0.0	2.2	7.1	153.2
Livingston	0.0	24.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.5
Logan	0.0	6.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.5
Macoupin	0.0	372.0	0.0	0.0	11.4	0.0	134.8	0.0	0.0	0.0	0.0	518.2
Madison	6.5	167.1	0.0	0.0	0.5	0.0	0.0	0.0	0.0	99.4	0.0	273.5
Marion	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.8
Marshall	0.0	5.9	0.0	0.0	48.2	0.0	0.0	0.0	0.0	0.0	0.0	54.1
McDonough	0.0	8.0	0.0	1.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	10.4

Table 7. Continued.

County	Unknown & Other	Private	Federal	State	County & City	Recreational Assoc.	Mining Company	Utility Company	Farm Corp.	Bank & Trust	Misc. Company	Total
McLean	1.0	1.5	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	4.5
Menard	0.0	10.3	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	10.5
Mercer	0.0	28.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.0
Montgomery	0.0	86.7	0.0	0.0	0.0	0.0	140.2	0.0	0.0	0.0	0.0	226.9
Morgan	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
Peoria	0.0	31.3	0.0	0.0	0.0	0.0	10.2	0.0	0.0	3.0	0.0	44.5
Perry	7.3	161.3	0.0	0.0	0.0	0.0	222.4	0.0	7.0	0.0	0.0	398.0
Putnam	39.3	24.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	64.1
Randolph	0.0	261.4	0.0	0.0	0.0	0.0	4.9	0.0	0.0	0.0	0.0	266.3
Rock Island	0.0	4.3	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	4.5
Saline	0.0	353.1	2.8	0.0	0.0	0.0	82.5	0.0	59.4	0.0	0.0	497.8
Sangamon	19.6	44.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	64.0
Schuyler	0.0	14.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	15.2
Scott	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
Shelby	0.0	12.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.0
Stark	0.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8
St. Clair	1.0	301.8	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	8.0	311.0
Tazewell	0.0	1.8	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	2.9
Vermilion	0.0	50.4	0.0	0.2	0.0	0.0	0.0	0.0	18.3	0.0	113.1	182.0
Warren	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4
Washington	0.0	7.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7	12.1
White	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0
Will	0.0	27.3	0.0	0.0	0.0	3.1	39.7	0.0	0.0	0.0	0.0	70.1
Williamson	0.0	429.2	0.0	0.0	0.0	0.0	249.7	0.0	5.0	4.8	112.2	800.9
Woodford	0.0	19.0	0.0	0.0	18.6	0.0	0.0	0.0	0.0	0.0	0.0	37.6
State	74.7	3,507.5	4.9	15.4	230.2	6.2	2,318.5	0.4	124.8	370.7	302.6	6,955.9

Illinois continue to be sources of air pollution, sedimentation, water pollution, and aesthetic degradation.

Gob refuse areas totaling 3,943.5 acres were recorded in 53 counties (Table 3, Figure 10). Refuse areas ranged from 0.1 to 323.0 acres at 691 sites (638 mines). At 53 mines, more than one gob refuse site was delineated based on vegetational, physical, and location criteria. Five counties, Franklin (627.2 acres), Christian (519.9 acres), Saline (359.0 acres), Williamson (355.0 acres), and Macoupin (191.1 acres), contained 52.0 percent of the total gob acreage reported. Williamson County (72 sites), Fulton County (58 sites), St. Clair County (35 sites), Grundy County (34 sites), and La Salle County (34 sites) contained the greatest number of gob refuse areas. The largest exposed abandoned mine refuse area (117.3 acres, 1.9 million cubic yards) was located in Saline County. Gob refuse volume for the entire state totaled an estimated 71.4 million cubic yards (Table 8).

Burning refuse piles were once considered a necessary evil of coal mining regardless of the associated environmental, health, and safety ramifications (Coalgate et al. 1973). Gob refuse areas which had burned in the past as indicated by pink or red surface discoloration, commonly called "red dog," were recorded at 220 sites. Actively burning gob refuse piles were recorded at six sites; the amount burning was not extensive. In 1968, the U. S. Bureau of Mines reported 14 burning gob refuse piles in nine Illinois counties (Stahl 1964). The most extensively burned gob piles were recorded in northern counties. Gob piles with more than 50 percent of the total area burned were recorded at 45 sites. These extensively burned sites contained an estimated 28.3 million

Table 8. Volume, and acreage per height category of abandoned underground coal mine gob refuse in Illinois counties as of 1 September 1976.

County	Gob Volume (Cu. Yds.)	Acres Per Gob Height (Feet) 0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81+	Total
Bond	2,523	0.4	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.7
Brown	92	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Bureau	16,647,480	0.1	17.0	0.0	0.0	9.0	3.4	14.8	0.0	98.4	142.7
Calhoun	3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Cass	312	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Christian	170,279	193.7	2.1	0.0	1.1	323.0	0.0	0.0	0.0	0.0	519.9
Clinton	43,407	10.8	4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.3
Crawford	347	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Edgar	118,398	2.2	0.3	0.0	0.0	0.0	0.0	0.0	3.5	0.0	6.0
Franklin	2,408,873	341.1	179.4	24.0	82.7	0.0	0.0	0.0	0.0	0.0	627.2
Fulton	450,147	31.5	6.0	0.0	4.7	0.0	0.0	0.0	0.0	0.0	42.2
Gallatin	11,054	16.8	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.0
Greene	45	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
Grundy	1,490,265	13.2	13.7	13.6	6.1	9.4	15.1	5.3	27.9	19.8	124.1
Hancock	5,968	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
Henry	484,326	8.8	12.0	0.0	0.6	0.0	0.0	1.4	0.0	0.0	22.8
Jackson	1,127,542	19.4	6.8	5.3	61.3	0.0	0.0	17.0	0.0	0.0	109.8
Jasper	943	0.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6
Jersey	266	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Kankakee	46,000	2.5	0.0	0.0	4.1	0.0	0.0	0.0	0.0	0.0	6.6
Knox	144,499	4.1	5.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.6
La Salle	9,719,836	9.9	18.8	25.4	13.1	10.8	7.1	16.5	29.8	0.0	131.4
Livingston	784,550	0.1	1.1	9.8	0.5	1.0	0.0	0.0	2.7	0.0	15.2
Logan	9,469	0.0	3.4	0.8	0.0	0.0	0.0	0.0	0.0	0.0	4.2
Macoupin	4,037,126	6.6	15.8	47.0	35.0	24.8	52.1	9.8	0.0	0.0	191.1
Madison	4,245,637	18.7	37.2	4.1	49.9	0.0	0.0	29.6	0.0	15.6	155.1
Marion	6,937	0.3	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8
Marshall	3,960,690	0.9	9.1	4.1	0.5	0.0	0.0	0.0	9.0	26.0	49.6
McDonough	169,904	3.6	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.8

Table 8. Continued.

County	Gob Volume (Cu. Yds.)	Acres Per Gob Height (Feet) 0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81+	Total
McLean	69,000	0.0	2.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	4.5
Menard	33,335	1.1	0.7	3.5	0.0	0.0	0.0	0.0	0.0	0.0	5.3
Mercer	286,386	7.7	13.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.3
Montgomery	1,944,098	63.8	1.4	69.6	0.0	0.0	0.0	0.0	0.0	0.0	134.8
Morgan	3,767	0.2	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.4
Peoria	1,350,128	7.9	14.0	0.0	0.0	0.0	0.0	0.0	3.0	6.0	30.9
Perry	3,255,180	64.8	2.6	2.5	47.8	0.0	0.0	40.0	0.0	0.0	157.7
Putnam	4,224,000	0.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	46.6	56.6
Randolph	1,062,850	15.9	0.4	0.0	91.9	0.0	0.0	0.0	0.0	0.0	108.2
Rock Island	48,258	2.3	0.1	1.9	0.0	0.0	0.0	0.0	0.0	0.0	4.3
Saline	2,047,149	238.1	3.6	117.3	0.0	0.0	0.0	0.0	0.0	0.0	359.0
Sangamon	269,664	33.7	18.2	4.5	0.0	0.0	0.0	0.0	0.0	0.0	56.4
Schuyler	111,517	8.9	5.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.2
Scott	475	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
Shelby	12,000	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6
Stark	13,389	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7
St. Clair	2,689,430	52.0	0.9	0.0	26.9	0.0	96.3	11.1	0.0	0.0	187.2
Tazewell	6,776	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4
Vermilion	3,300,325	12.7	34.1	3.9	0.0	2.0	3.3	48.8	0.0	47.9	152.7
Washington	15,457	3.4	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.6
White	198	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0
Will	345,599	22.9	7.9	3.9	7.8	3.1	1.8	0.0	2.8	0.0	50.2
Williamson	1,684,855	235.6	83.9	20.9	11.6	3.0	0.0	0.0	0.0	0.0	355.0
Woodford	2,579,000	0.0	0.0	0.0	0.0	0.0	0.0	5.5	9.3	11.8	26.6
State	71,439,754	1,465.4	542.3	364.9	445.8	386.1	179.1	199.8	88.0	272.1	3,943.5

cubic yards of refuse material. Refuse piles with less than 25 percent burned area were recorded at 153 additional sites and contained an estimated 18.8 million cubic yards of material.

Height of gob refuse areas ranged from a few inches, usually associated with scattered gob, to conical or terraced piles of 90 feet or more (Table 8). Size and shape of refuse piles was related to the disposal method which included dumping by trucks, conveyor belts, and mine cars. Configurations of refuse piles most often encountered included flat or gently sloping, flat top terraces, and cone or conical shapes. The simplest dumping methods, using mine cars or conveyer belts, deposited refuse over long, sloping inclines of previously deposited refuse to a dumping point at the top of the gob pile. Most gob piles (612) were less than 40 feet high; 71 exceeded 40 feet. Counties with the greatest extent of gob refuse piles exceeding 40 feet in height were: Christian (323.0 acres), Bureau (125.6 acres), St. Clair (107.4 acres), Vermilion (102.0 acres), Macoupin (86.7 acres), and Grundy (77.5 acres) (Table 8). Refuse areas that exceeded 40 feet in height contained an estimated 50.2 million cubic yards of material. Gob refuse less than 40 feet high contained an estimated 21.2 million cubic yards.

Gob pile composition and refuse texture are related to differences in mining techniques, seam mined, coal preparation, and gob disposal methods. Refuse piles associated with thick seams contain a greater percentage of bone or low grade coal, while refuse piles associated with thinner seams have a higher percentage of clay, shale, and rock (Coalgate et al. 1973). Most refuse areas contained varying amounts of coal, rock, shale, pyrite, discarded mining machinery, decayed timbers, and associated

debris. Gob refuse containing a large percentage of rock, shale, and/or clay totaling 48.4 million cubic yards were recorded at 400 sites. Refuse piles of this nature were most often associated with the longwall mining region of northern Illinois. Longwall mining, which worked thinner seams, was nearly twice as efficient as conventional room and pillar mining in the amount of coal removed. However, longwall mining was ultimately more expensive due to the need to remove large amounts of rock, shale, and clay that prematurely subsided into the haulage ways (Illinois Department of Mines and Minerals 1944a). Refuse areas associated with the thicker coal seams mined by conventional room and pillar methods in southern and central counties were composed of a higher percentage of low grade coal and shale, with lesser amounts of clay and rock. Gob refuse composed of these materials was recorded at 276 sites and consisted of an estimated 18.6 million cubic yards.

Slope of gob refuse areas ranged from nearly level to more than 45 percent (Table 9). More than three-fourths of the refuse piles (548 sites) exhibited slopes less than 30 percent. Slopes exceeding 30 percent were recorded at 144 sites. Slopes were related to method of disposal and past treatment. Gob piles with the steepest slopes most often occurred in northern counties where the oldest mines predominate.

Steeply sloped, unvegetated gob material was highly susceptible to erosion. Refuse composition, degree of compaction, slope, and density of vegetation determined the severity of erosion. The erosion condition of gob areas was delineated as: 1) sheet erosion; no rills or gullies, 2) rills; less than 1 foot deep, and 3) gullies; more than 1 foot deep. Sheet erosion was recorded at 254 gob refuse sites, with rills recorded

Table 9. Acreage per erosion condition and percent slope for underground coal mine gob refuse areas in Illinois counties as of 1 September 1976.

County	Erosion Condition			Slope					Total
	Sheet	Rills	Gullies	0-2	3-15	16-30	31-45	46+	
Bond	0.4	0.3	0.0	0.0	0.4	0.3	0.0	0.0	0.7
Brown	0.0	0.2	0.0	0.0	0.1	0.1	0.0	0.0	0.2
Bureau	0.1	0.0	142.6	0.1	14.0	6.4	60.0	62.2	142.7
Calhoun	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1
Cass	0.0	0.1	0.1	0.0	0.1	0.0	0.1	0.0	0.2
Christian	0.0	330.2	189.7	0.0	19.6	499.2	1.1	0.0	519.9
Clinton	10.7	4.6	0.0	8.1	2.7	1.9	2.6	0.0	15.3
Crawford	0.0	0.2	0.0	0.0	0.2	0.0	0.0	0.0	0.2
Edgar	0.0	0.3	5.7	0.0	2.2	0.3	3.5	0.0	6.0
Franklin	181.2	98.7	347.3	259.4	136.4	124.7	33.9	72.8	627.2
Fulton	25.4	5.6	11.2	14.1	21.0	2.4	4.7	0.0	42.2
Gallatin	8.6	1.1	7.3	16.6	0.0	0.2	0.0	0.2	17.0
Greene	0.3	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.3
Grundy	1.3	0.0	122.8	6.0	9.6	8.8	20.7	79.0	124.1
Hancock	0.2	0.3	0.0	0.2	0.3	0.0	0.0	0.0	0.5
Henry	8.5	0.5	13.8	3.5	10.1	7.8	0.0	1.4	22.8
Jackson	9.9	2.9	97.0	15.4	2.2	5.3	69.9	17.0	109.8
Jasper	0.5	0.0	0.1	0.0	0.2	0.4	0.0	0.0	0.6
Jersey	0.2	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.2
Kankakee	3.2	0.0	3.4	0.0	0.0	2.5	3.2	0.9	6.6
Knox	4.1	0.0	5.5	3.1	1.0	5.5	0.0	0.0	9.6
La Salle	6.4	19.6	105.4	9.8	23.7	23.4	73.1	1.4	131.4
Livingston	0.1	0.8	14.3	0.0	4.0	5.0	6.2	0.0	15.2
Logan	4.2	0.0	0.0	0.0	0.0	0.0	3.4	0.8	4.2
Macoupin	34.3	5.5	151.3	34.0	11.8	15.9	89.9	39.5	191.1
Madison	1.1	12.1	141.9	0.1	39.7	56.2	34.4	24.7	155.1
Marion	0.5	0.0	0.3	0.3	0.5	0.0	0.0	0.0	0.8
Marshall	0.7	10.2	38.7	0.7	10.3	12.6	0.0	26.0	49.6
McDonough	6.1	3.1	0.6	0.5	8.6	0.7	0.0	0.0	9.8

Table 9. Continued.

County	Erosion Condition			Slope					Total
	Sheet	Rills	Gullies	0-2	3-15	16-30	31-45	46+	
McLean	1.0	2.0	1.5	0.0	3.0	1.5	0.0	0.0	4.5
Menard	0.1	2.8	2.4	0.8	0.2	1.7	2.6	0.0	5.3
Mercer	1.9	12.0	7.4	0.0	21.3	0.0	0.0	0.0	21.3
Montgomery	0.2	1.5	133.1	0.0	58.1	1.6	75.1	0.0	134.8
Morgan	0.2	0.0	0.2	0.0	0.2	0.0	0.2	0.0	0.4
Peoria	18.7	9.2	3.0	9.5	12.4	3.0	6.0	0.0	30.9
Perry	51.8	44.8	61.1	58.5	6.3	40.3	1.9	50.7	157.7
Putnam	0.0	0.0	56.6	0.0	10.0	0.0	0.0	46.6	56.6
Randolph	8.4	0.2	99.6	7.6	6.7	2.0	91.9	0.0	108.2
Rock Island	2.4	0.0	1.9	2.2	0.1	2.0	0.0	0.0	4.3
Saline	46.5	19.3	293.2	201.3	36.8	3.6	0.0	117.3	359.0
Sangamon	21.3	19.3	15.8	22.5	27.6	5.7	0.6	0.0	56.4
Schuyler	3.4	4.2	6.6	1.4	7.5	5.3	0.0	0.0	14.2
Scott	0.4	0.1	0.0	0.3	0.1	0.1	0.0	0.0	0.5
Shelby	2.6	0.0	0.0	0.0	2.6	0.0	0.0	0.0	2.6
Stark	0.7	0.0	1.0	0.2	0.5	1.0	0.0	0.0	1.7
St. Clair	18.6	9.2	159.4	25.7	23.7	2.6	27.8	107.4	187.2
Tazewell	2.4	0.0	0.0	2.4	0.0	0.0	0.0	0.0	2.4
Vermilion	7.6	0.8	144.3	7.9	14.5	27.7	52.7	49.9	152.7
Washington	3.4	1.2	0.0	3.4	0.0	1.2	0.0	0.0	4.6
White	3.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0	3.0
Will	6.8	0.0	43.0	17.0	3.9	6.1	8.8	14.4	50.2
Williamson	42.2	62.2	250.6	171.2	75.2	55.9	37.6	15.1	355.0
Woodford	0.0	0.0	26.6	0.0	0.0	5.5	21.1	0.0	26.6
State	551.7	685.1	2,706.1	906.8	629.9	946.5	733.0	727.3	3,943.5

at 123 sites and gullies at 315 sites (Table 9). Gullies as deep as 6 to 8 feet constituted the most severe erosion observed. Gully erosion was associated with 2,706.7 acres, while rill and sheet erosion affected 685.1 and 551.7 acres, respectively. Severe erosion resulted in sediment deposition up to 1/2 mile downstream from refuse areas. Erosion also continually exposes unoxidized pyritic materials in the refuse piles.

The majority of gob refuse areas (509) had received no apparent treatment to reduce sedimentation or drainage problems (Figure 11). Graded refuse areas were recorded at 74 sites; covered refuse was documented at 6 sites. Graded and covered refuse areas were recorded at 12 sites. Peabody Coal Company graded and soil-covered several refuse piles ranging from 23 to 247 acres in Christian County (Deane 1968). Freeman United Coal Mining Corporation was currently grading and covering a 48-acre gob area at the Orient No. 5 Mine in Franklin County. In addition, smaller refuse areas throughout the state, including 27 acres in Saline County, were graded and covered by private individuals or other mining companies. Experimental grading and covering of a gob refuse area at the New Kathleen Mine (Perry County) was conducted by the Truax-Traer Coal Company (currently Consolidation Coal Company) in cooperation with the Water Quality Office of the Environmental Protection Agency (Barthauer et al. 1971). Reclamation and revegetation programs for gob sites are being conducted by Argonne National Laboratory at an abandoned deep mine near Staunton in Macoupin County.

Utilization of refuse areas, varying with the composition, size, location, and degree of revegetation, included: 1) no apparent, 2)

Figure 11. Drainage and sedimentation from a 29-acre barren gob pile has adversely affected a 22-acre adjacent terrestrial area and a 21-acre water impoundment at an abandoned underground mine in Macoupin County.

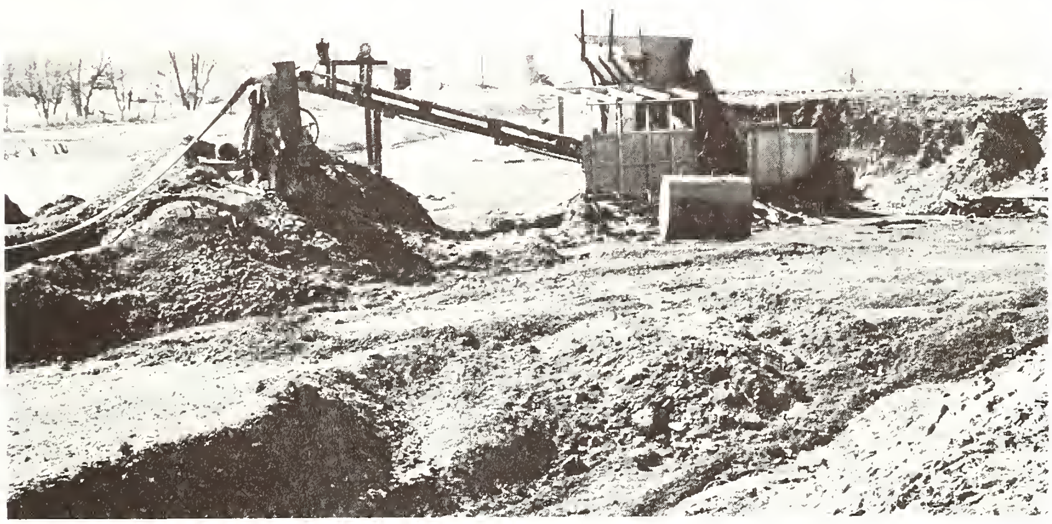

Figure 12. Reprocessing of a 32-acre abandoned gob pile in Williamson County recovered coal which was discarded as waste when the mine operated in the early 1950's.

recreational, 3) dump, 4) utilized by an active mine, 5) recovery operation for coal, and 6) other. Current use of gob piles was not recorded for 455 sites. Recreation, including trail bike and horseback riding, hunting, and hiking, was observed at 20 sites. Private and/or public landfills or dumps were recorded at 77 sites. Nine gob refuse sites were being subjected to carbon recovery operations (Figure 12); the largest included the Valier Mine in Franklin County and the Harco Mine in Saline County. Miscellaneous uses of refuse areas were recorded at 131 sites. "Red dog" was being utilized by shale companies and/or private individuals for road construction, driveway surfacing, and landscaping. Where there was suitable revegetation, livestock were often pastured on refuse areas. A scenic overlook had been constructed on the abandoned Wenona Coal Company gob pile in Marshall County. A memorial to the 259 men who lost their lives in a 1909 mine disaster near Cherry (Bureau County) was associated with the remains of a 19-acre gob refuse area.

Gob refuse areas contributed 56.7 percent of the total acres disturbed by underground coal mining in Illinois (Figure 10). Large volumes and extensive acreages of severely eroded refuse areas constitute a previously unavoidable by-product of nearly a century and a half of underground mining. Therefore, the physical characterization of gob refuse areas is an important aspect in evaluating potential reclamation problems. Successful reclamation will ultimately depend upon a comprehensive analysis of related problems and formulations of viable solutions on a site by site basis.

Gob - Vegetational Characteristics

Vegetation was present on 609 of the 691 abandoned gob refuse areas surveyed; successional stages varied from barren at 82 sites (673.1 acres) to forested at 124 sites (202.6 acres) (Table 10, Figure 13). Herbs, shrubs, and small trees, occurring on 259 gob refuse areas (1,900.6 acres), represented the predominant successional stage. Early invaders, consisting of grasses and herbs, occurred on 226 refuse areas (1,167.2 acres). In comparison to larger sites which were vegetated by less advanced successional stages, forest vegetation characterized small mines that had been abandoned for many years.

Ground cover vegetation, present on 602 sites, was restricted to the lower slope or perimeter of 262 sites (43.5 percent). Ground cover vegetation was scattered (clusters of vegetation interspersed with barren areas) at 213 sites (35.4 percent) and uniformly distributed at 107 sites (17.8 percent). In general, distribution of the vegetation was related to the size of the refuse area. Small sites exhibited scattered to uniformly distributed vegetation, whereas large sites were characterized by vegetated perimeters or lower slopes, and barren to sparsely vegetated interiors or upper slopes.

Density of ground cover vegetation varied from barren or sparse at 289 sites (1,710.4 acres) to excellent at 25 sites (165.9 acres) (Table 11). Poor to fair ground cover vegetation occurred at 301 sites (1,243.7 acres); good cover was present at 76 sites (823.5 acres). Vegetation density was generally greater on small refuse sites as compared to large sites due to the longer period of time required for natural invasion.

Table 10. Affected acreage per successional stage and ground cover density of gob, slurry, and tipple areas of abandoned underground coal mines in Illinois counties as of 1 September 1976.

County	Successional Stage				Ground Cover Density (Percent Cover)					Total
	Barren	Early Invaders	Herbs, Shrubs & Trees	Forest	0-10	11-25	26-50	51-75	76+	
Bond	0.0	0.0	1.4	0.7	0.4	0.0	1.7	0.0	0.0	2.1
Brown	0.0	0.1	0.1	0.0	0.2	0.0	0.0	0.0	0.0	0.2
Bureau	15.4	11.0	116.0	13.4	102.7	53.0	0.1	0.0	0.0	155.8
Calhoun	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1
Cass	0.0	0.2	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.2
Christian	11.9	165.0	346.9	0.0	18.4	14.1	168.1	323.2	0.0	523.8
Clinton	2.3	11.1	3.5	1.9	4.2	8.5	0.0	0.0	6.1	18.8
Crawford	0.0	0.0	0.2	0.0	0.0	0.2	0.0	0.0	0.0	0.2
Edgar	0.0	0.0	6.0	1.7	3.8	2.2	0.0	1.7	0.0	7.7
Franklin	185.4	319.7	612.1	1.0	371.8	236.9	147.5	239.5	122.2	1,118.2
Fulton	7.1	25.2	20.7	8.2	14.8	12.5	10.9	8.1	14.9	61.2
Gallatin	5.6	3.8	7.1	3.1	16.3	0.2	2.9	0.2	0.0	19.6
Greene	0.0	0.0	0.0	0.3	0.1	0.2	0.0	0.0	0.0	0.3
Grundy	83.0	47.5	25.4	6.5	106.2	30.3	18.3	4.9	2.7	162.4
Hancock	0.0	0.0	0.5	0.0	0.1	0.4	0.0	0.0	0.0	0.5
Henry	0.0	9.6	23.9	0.4	1.4	13.2	5.3	8.0	6.0	33.9
Jackson	11.9	30.0	79.7	10.3	33.2	76.3	14.1	7.3	1.0	131.9
Jasper	0.0	0.0	0.1	0.5	0.0	0.0	0.4	0.1	0.1	0.6
Jefferson	0.0	16.9	0.0	0.0	0.0	0.0	16.9	0.0	0.0	16.9
Jersey	0.0	0.1	0.0	0.1	0.1	0.0	0.1	0.0	0.0	0.2
Kankakee	0.0	0.9	2.5	3.2	0.9	2.5	0.0	3.2	0.0	6.6
Knox	0.0	0.0	10.9	1.0	5.5	0.1	2.3	3.0	1.0	11.9
La Salle	2.6	40.4	49.4	45.6	58.9	35.4	14.6	11.9	17.2	138.0
Livingston	2.5	5.7	6.0	3.7	4.6	10.0	0.6	2.7	0.0	17.9
Logan	0.0	0.0	6.5	0.0	0.8	0.0	0.0	5.7	0.0	6.5
Macoupin	57.7	105.5	104.2	0.2	199.8	18.6	49.2	0.0	0.0	267.6
Madison	21.1	41.7	132.0	0.1	85.5	46.7	62.3	0.2	0.2	194.9

Table 10. Continued.

County	Successional Stage: Barren	Successional Stage: Early Invaders	Successional Stage: Herbs, Shrubs & Trees	Successional Stage: Forest	Ground Cover Density (Percent Cover): 0-10	11-25	26-50	51-75	76+	Total
Marion	0.3	0.0	0.5	0.0	0.3	0.0	0.0	0.5	0.0	0.8
Marshall	0.0	0.2	25.5	23.9	10.9	28.0	0.0	10.7	0.0	49.6
McDonough	0.0	1.9	1.9	6.5	7.6	0.5	2.2	0.0	0.0	10.3
McLean	0.0	0.0	4.5	0.0	0.0	0.0	4.5	0.0	0.0	4.5
Menard	0.0	2.0	5.2	0.0	2.5	1.1	1.5	2.1	0.0	7.2
Mercer	6.0	4.6	1.0	15.4	7.6	0.0	1.3	18.0	0.1	27.0
Montgomery	63.2	0.1	121.8	2.4	69.6	102.9	14.2	0.8	0.0	187.5
Morgan	0.1	0.1	0.2	0.0	0.4	0.0	0.0	0.0	0.0	0.4
Peoria	0.0	17.7	14.7	12.0	4.2	3.0	15.8	10.8	10.6	44.4
Perry	40.9	142.6	81.1	15.5	110.7	15.8	70.4	78.1	5.1	280.1
Putnam	56.6	7.5	0.0	0.0	56.6	0.0	2.0	5.5	0.0	64.1
Randolph	88.4	92.9	5.6	8.2	165.1	1.9	5.6	3.6	18.9	195.1
Rock Island	0.0	0.0	1.9	2.6	2.3	0.1	0.2	0.0	1.9	4.5
Saline	21.1	162.8	256.7	1.0	167.0	60.9	11.7	148.6	53.4	441.6
Sangamon	0.2	8.9	50.5	0.0	6.9	2.5	36.5	13.7	0.0	59.6
Schuyler	1.3	6.2	1.4	6.3	1.8	7.7	4.3	0.9	0.5	15.2
Scott	0.0	0.1	0.3	0.1	0.5	0.0	0.0	0.0	0.0	0.5
Shelby	0.0	1.1	2.6	0.0	1.1	0.0	2.6	0.0	0.0	3.7
Stark	0.0	1.1	0.0	0.6	0.6	1.0	0.1	0.0	0.0	1.7
St. Clair	169.1	43.7	79.6	4.8	234.7	8.9	23.0	12.0	18.6	297.2
Tazewell	1.5	0.0	0.0	1.4	2.4	0.0	0.0	0.5	0.0	2.9
Vermilion	83.6	10.0	80.9	7.1	121.4	34.9	4.8	13.7	6.8	181.6
Washington	0.0	6.5	0.4	4.7	3.5	1.2	6.9	0.0	0.0	11.6
White	0.0	0.0	3.0	0.0	0.0	0.0	3.0	0.0	0.0	3.0
Will	18.0	29.1	17.9	3.7	42.1	13.0	2.4	4.8	6.4	68.7
Williamson	41.7	341.2	130.5	45.6	216.7	165.7	75.8	82.0	18.8	559.0
Woodford	0.0	11.8	14.8	4.1	21.1	5.5	0.0	4.1	0.0	30.7
State	998.5	1,726.6	2,457.6	267.8	2,287.4	1,016.1	804.1	1,030.1	312.8	5,450.5

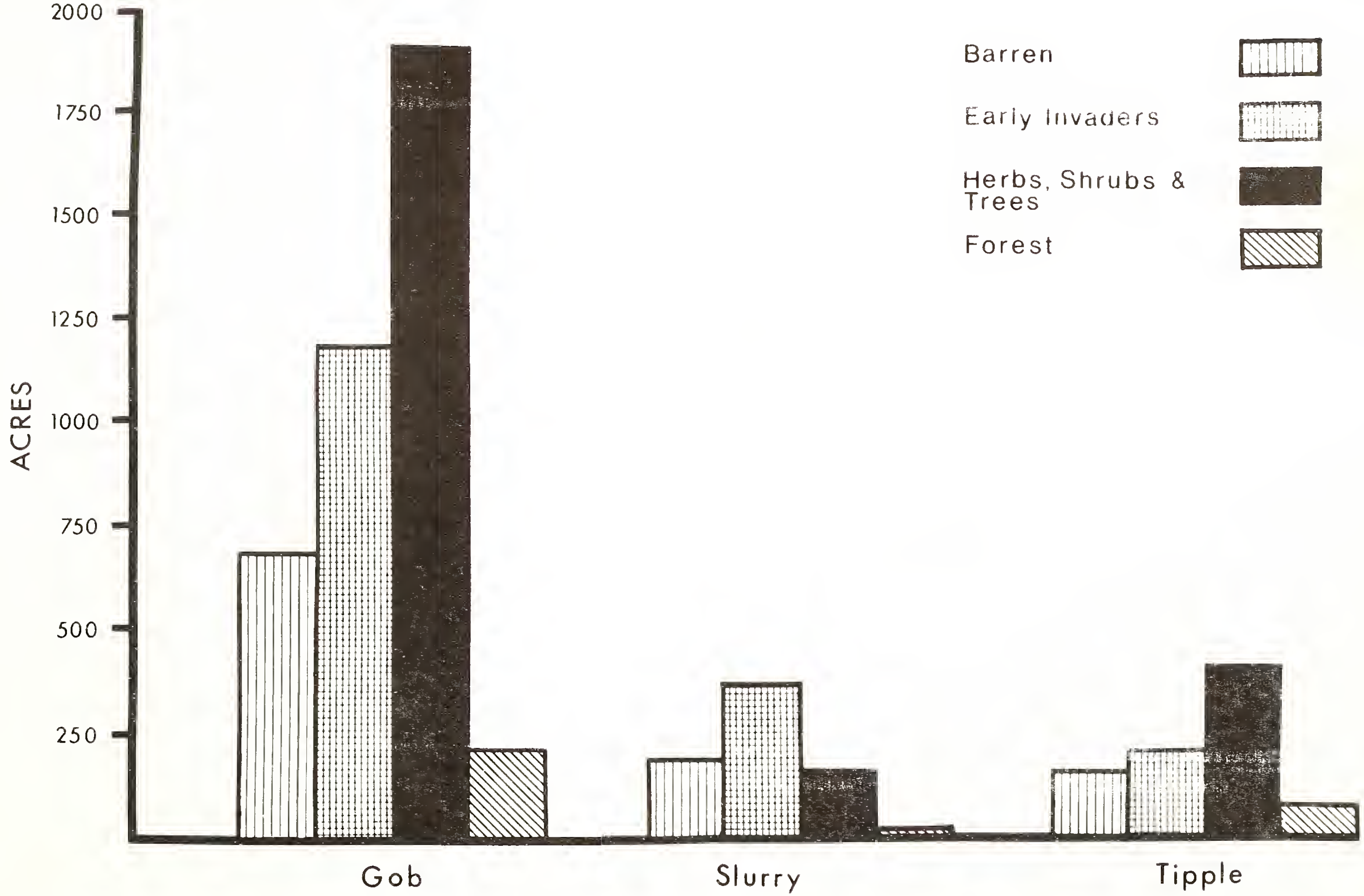

Figure 13. Affected acres by successional stage of vegetation for gob, slurry, and tipple areas on abandoned underground coal mine sites in Illinois as of 1 September 1976.

Table 11. Acreage and number of sites per ground cover density for abandoned underground mine areas in Illinois as of 1 September 1976.

	Barren-10%		11%-25%		26%-50%		51%-75%		75%+	
	#	Acres	#	Acres	#	Acres	#	Acres	#	Acres
Gob	289	1,710.4	167	572.8	134	670.9	76	823.5	25	165.9
Slurry	36	371.7	10	295.2	2	7.7	4	19.2	0	0.0
Tipple	41	205.3	17	148.1	31	125.5	46	187.4	57	146.9
Total	366	2,287.4	194	1,016.1	167	804.1	126	1,030.1	83	312.8

Extensive erosion also inhibited adequate vegetation establishment on large sites.

Naturally occurring ground cover vegetation was present on 554 gob sites, while 39 sites supported both natural and planted species; 5 sites supported only domestic species. Fescue (Festuca spp.) and lespedeza (Lespedeza spp.) were frequently observed as planted species on gob refuse piles, particularly when portions of refuse areas had been graded and/or covered and were located on pasture land. At one graded and soil-covered mine site in Saline County, wheat (Triticum aestivum) had been utilized as an initial soil stabilizing species. Native species later invaded and successfully vegetated this site. Broom-sedge (Andropogon virginicus) was the most frequently recorded dominant ground cover species on gob refuse sites. Broom-sedge, three-awn grasses (Aristida spp.), blackberry (Rubus spp.), and rose (Rosa spp.) were the dominant species on 45.0 percent of the gob sites surveyed (Figure 14). Other dominant ground cover species included dock (Rumex spp.), sweet clover (Melilotus spp.), foxtail (Setaria spp.), sumac (Rhus spp.), and poison ivy (Rhus radicans).

Overstory vegetation, present on 460 sites, was restricted to the lower slope or perimeter of 205 sites (44.6 percent) (Figure 15). Scattered and uniformly distributed overstory was observed at 183 sites (39.8 percent) and 48 sites (10.4 percent), respectively. Density of overstory varied from barren to light at 492 sites to heavy on 13 sites. Moderate overstory vegetation density was recorded at 187 sites (Figure 16).

Invasion by naturally occurring species accounted for overstory

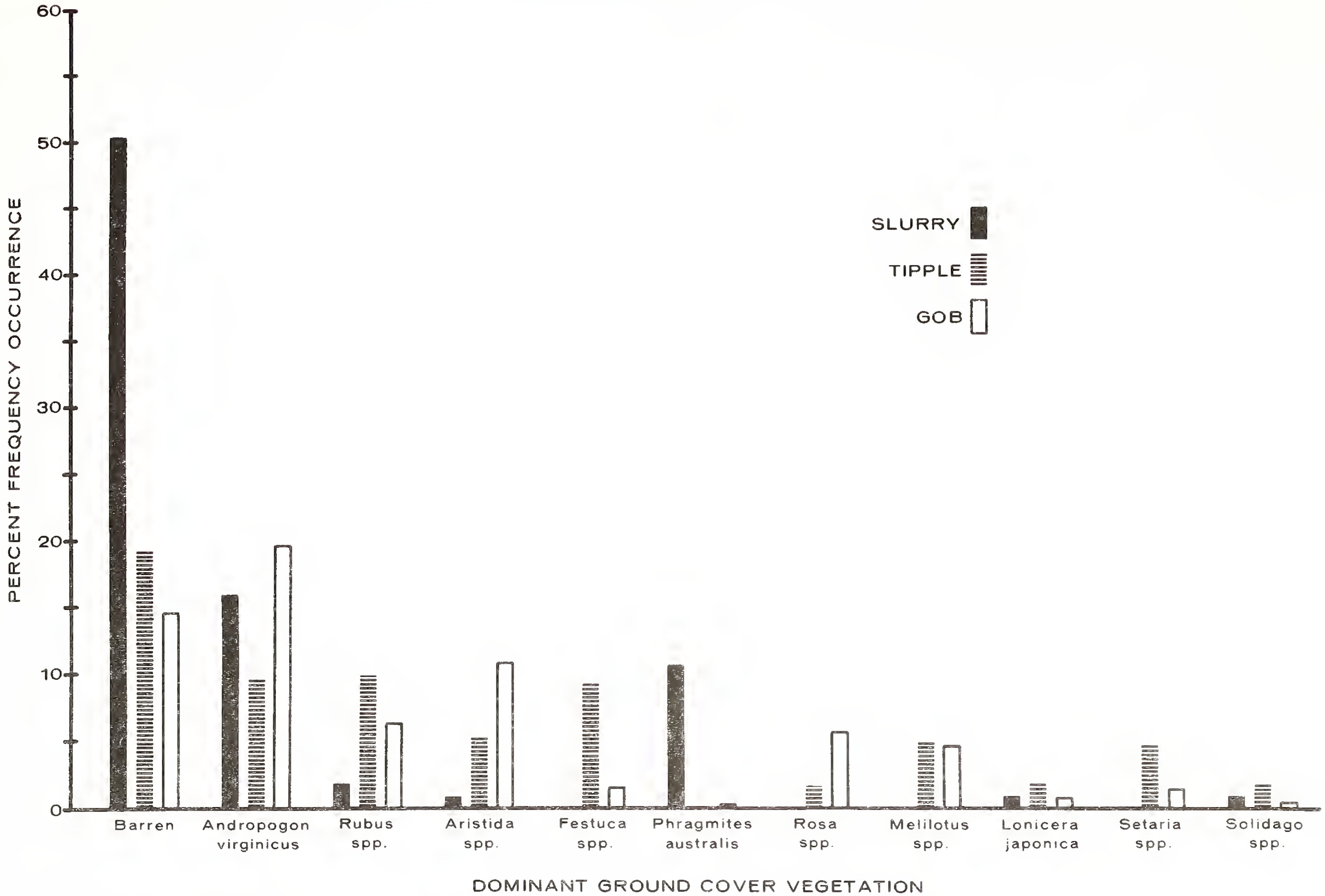

Figure 14. Percent frequency occurrence of 10 dominant ground cover species observed on gob, slurry, and tipple areas of abandoned underground coal mines in Illinois as of 1 September 1976.

Figure 15. Dominant overstory vegetation, restricted to the perimeter of a 4-acre abandoned gob area in Gallatin County, consisted of box elder (Acer negundo), and elm (Ulmus spp.).

Figure 16. Moderate overstory vegetation consisting of black locust (Robinia pseudoacacia), box elder (Acer negundo), and wild cherry (Prunus spp.), was present on a 9-acre gob pile in Marshall County abandoned in 1926. (Photo by A. L. Dooley)

vegetation at 445 sites. Planted and naturally occurring species were observed on 15 sites; 2 sites supported only planted overstory species. Russian olive (Elaeagnus angustifolia) and pine (Pinus spp.) were planted species observed on gob refuse sites. Of those gob refuse areas with overstory cover, 278 sites (60.8 percent) supported trees with a DBH (diameter at breast height) of 6.0 inches or less; 179 sites (39.2 percent) supported trees with a DBH of over 6.0 inches. Wild cherry (Prunus spp.) occurred most frequently as the dominant overstory species on gob refuse areas (15.6 percent). Other dominant species included pin oak (Quercus palustris), elm (Ulmus spp.), shingle oak (Q. imbricaria), cottonwood (Populus deltoides), box elder (Acer negundo), and sycamore (Platanus occidentalis) (Figure 17).

Overstory cover on large gob refuse areas was usually scattered and of short stature as compared to the uniform distribution and greater height of overstory growth on small gob refuse areas, indicating less favorable growth conditions. Factors contributing to these unfavorable conditions included: 1) instability and erodibility of the refuse material, 2) high surface temperatures, 3) inadequate soil moisture, 4) nutrient deficiency, and 5) presence of toxic elements.

In addition to the harsh physical conditions of gob refuse, adverse chemical conditions also inhibited vegetation establishment. A preliminary evaluation of refuse samples collected from unburned portions of 333 poorly vegetated abandoned gob piles revealed toxic growth medium conditions as demonstrated by low pH values, high concentrations of soluble salts, and high acid-producing potentials (Table 12). Only 10 percent (33) of the gob samples exhibited pH

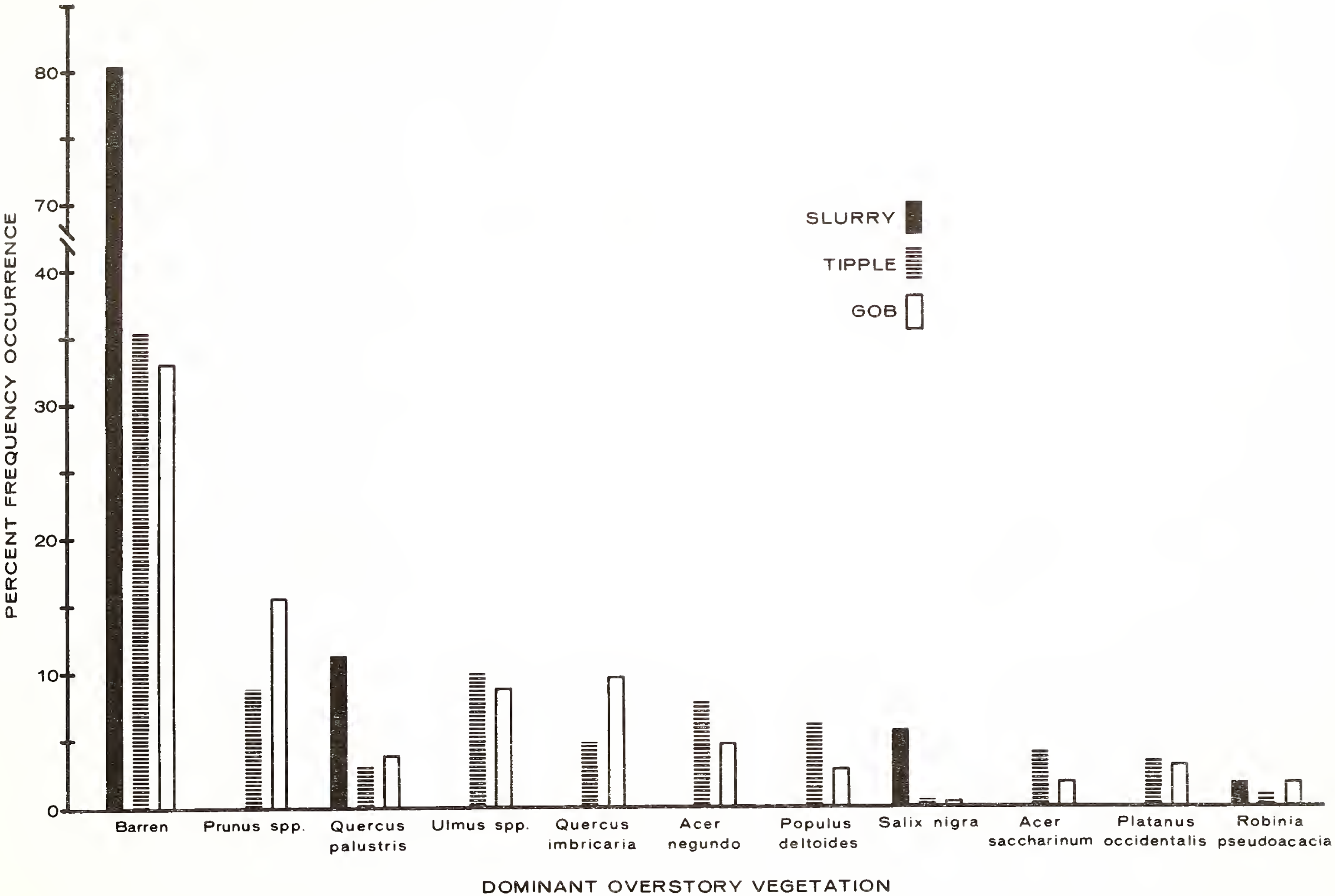

Figure 17. Percent frequency occurrence of 10 dominant overstory species observed on gob, slurry, and tipple areas of abandoned underground coal mines in Illinois as of 1 September 1976.

Table 12. Chemical-statistical data for 449 gob and 52 slurry samples from abandoned underground mines in Illinois.[a]

Refuse Type	Number of Samples	$\overline{X}$	Median	SD	Max	Min
Unburned gob	333					
pH		2.9	2.7	1.06	8.0	1.2
Conductivity, micro-mhos/cm		5200	3200	7090	95000	220
Potential acidity, meq H^+/100 g		113	87	99.6	698	0
Burned gob	116					
pH		3.8	3.7	1.02	6.8	1.9
Conductivity, micro-mhos/cm		3500	2300	4600	25700	160
Potential acidity, meq H^+/100 g		17	12	18.5	141	0
Slurry	52					
pH		3.2	2.6	1.49	8.1	1.6
Conductivity, micro-mhos/cm		3700	3000	2590	11400	300
Potential acidity, meq H^+/100 g		187	168	132.2	714	11

[a]Data have been rounded to levels of significance compatible with precision and accuracy.

values greater than 4.0. Surface-mine spoils are considered toxic when pH is less than 4.0 over more than 75 percent of the area sampled (Limstrom 1948).

In addition to the direct toxic effects on plant metabolism, metallic ion concentrations reach toxic levels for most plants when the pH is below 4.0 (Berg 1965). High soluble salt concentrations associated with low pH contribute to vegetation failure by preventing seed germination, growth, or water uptake (Brady 1974). Conductivity, a measure of total soluble salts, ranged from 220 to 95,000 micro-mhos/cm for unburned gob (Table 12). Most agricultural soils exhibit conductivities of 1,000 to 2,000 micro-mhos/cm; above 4,000 micro-mhos/cm, plant growth is adversely affected (Jackson 1958). Thirty-eight percent (112) of the unburned gob samples had conductivities of 4,000 micro-mhos/cm or greater.

Potential acidity (expressed as milliequivalents of H^+/100 g) indicates the total acid-producing potential of the refuse if all the pyritic material were to oxidize as a result of continued weathering. The maximum amount of lime (based upon $CaCO_3$ equivalent) required to neutralize a given potential acidity can be determined using the following conversions (Smith et al. 1974):

1) meq H^+/100 g x 0.01 = ton H^+/thousand tons of material
2) one ton of H^+ requires 50 tons of $CaCO_3$ equivalent for neutralization
3) 1,000 tons of material is the theoretical weight of an acre furrow-slice (6" deep).

Therefore, the average potential acidity recorded for unburned gob (113 meq H^+/100 g) would require a maximum of 56 tons per acre of $CaCO_3$

to achieve neutralization. This assumes that little or no neutralization potential is provided by neutralizing bases in the refuse material. The most toxic gob sample reported (698 meq H^+/100 g) would require a maximum of 349 tons of lime per acre for neutraliztion. Although maximum lime requirements greater than 50 tons per acre may seem excessive in comparison to average agricultural lime requirements, direct liming and seeding is suggested as being a very economical alternative compared to the high cost of covering refuse areas with soil (Medvick and Grandt 1976).

Analysis of 116 burned gob samples indicated a less harsh chemical environment (Table 12); pH values greater than 4.0 were reported for 39 percent (45) of the samples. Conductivities in excess of 4,000 micro-mhos/cm were reported for only 18 percent (21) of the burned samples; potential acidities ranged from 0 to 141 meq H^+/100 g. The average potential acidity was only 17 meq H^+/100 g as compared to 113 meq H^+/100 g for unburned gob. Therefore, the maximum amount of lime required for neutralization of burned refuse samples (based on the average potential acidity of 17 meq H^+/100 g) would be 8.5 tons per acre.

Vegetation was often observed on burned portions of refuse, while an adjacent unburned area was barren. A small gob pile in Williamson County supported vegetation on the burned portion with a pH of 6.8, conductivity of 2,500 micro-mhos/cm, and a potential acidity of 4 meq H^+/100 g, while the adjacent unburned barren refuse had a pH of 2.3, conductivity of 4,500 micro-mhos/cm, and a potential acidity of 210 meq H^+/100 g. Although burning appears to ameliorate toxic chemical conditions, the harsh physical conditions associated with large burned

refuse piles are sufficiently severe to prevent adequate vegetation establishment. Also, gob piles are generally nutrient deficient; however, it is suggested that although this deficiency may be the cause of poor growth, it rarely accounts for the total lack of vegetation (Coalgate et al. 1973).

Slurry - Physical Characteristics

As the demand for cleaner coal increased, washing of raw coal became an integral part of its processing. Slurry effluent, a by-product of the coal washing process, created new disposal problems. Disposal of slurry was accomplished by either discharging into adjacent streams and ditches, or pumping into impoundments. Most impoundments were built of previously deposited gob refuse and/or clay.

Slurry refuse areas totaling 693.8 acres were recorded in 13 counties (Table 3). Impoundments ranged from 0.1 to 99.6 acres at 53 sites (38 mines). More than one slurry impoundment was recorded at 15 mines based on vegetational, physical, and location criteria. Three counties, Franklin (244.9 acres), Williamson (101.0 acres), and St. Clair (81.5 acres), contained 61.6 percent of the total slurry impoundment acreage. The largest impoundment (99.6 acres) was located at an abandoned mine in Franklin County.

Impoundments holding surface water ranging in depth from less than 1 inch to over 2 feet were recorded at 22 sites. Slow percolation of water through finely textured slurry refuse and the impermeability of some embankment structures resulted in the retention of surface water for an extended period following substantial rainfall.

Severity of erosion at slurry impoundments was determined by degree of vegetation, compaction, and condition of the embankment. The erosion condition of slurry impoundments was delineated as: 1) sheet erosion; no rills or gullies, 2) rills; less than 1 foot deep, and 3) gullies; more than 1 foot deep. Sheet erosion was recorded at 31 slurry areas, with rills recorded at 5 sites, and gullies at 17 sites. Gullies 10 to 12 feet deep, resulting from the collapse of embankments, characterized the most severe slurry erosion (Figure 18). Drainage of slurry sediment into adjacent streams and ditches as a result of collapsed embankments was observed at several mines in central Illinois (Figure 19). Sheet erosion was associated with 320.9 acres, while gully and rill erosion affected 236.1 and 136.7 acres, respectively.

The majority of slurry refuse areas (40) had received no apparent treatment to reduce erosion and sedimentation. Experimental covering of slurry refuse at the New Kathleen Mine (Perry County) was conducted by the Truax-Traer Coal Company (currently Consolidation Coal Company) in cooperation with the Water Quality Office of the Environmental Protection Agency (Barthauer et al. 1971). Varying amounts of slurry refuse were removed from nine sites; at the Harco Mine (Saline County) there had been complete carbon recovery.

Carbon recovery of slurry was observed at eight sites (188.9 acres). The largest recovery operations included the St. Ellen Mine and the St. Louis and O'Fallon Coal Company Eagle No. 2 Mine in St. Clair County, the Valier Mine and Franklin County Coal Corporation Mine No. 7 in Franklin County, and the Lumaghi Coal Company Mine No. 2 in Madison County. No present use of slurry impoundments was recorded at 43 sites.

Figure 18. Severe erosion consisting of 10- to 12-foot gullies characterized more than 17 acres of slurry at an abandoned underground mine in Macoupin County.

Figure 19. Erosion of embankments resulted in slurry sedimentation escaping to adjacent ditches and fields.

Although slurry areas accounted for only 9.9 percent of the total acreage affected by abandoned mines, they represented a much greater potential for off-site disturbance through problems associated with erosion and sedimentation. The continued demand for clean coal and the economic necessity of recovering all useable coal from the raw product will produce a slurry effluent in the future with little or no recovery value. Consequently, disposal and reclamation of slurry effluent will constitute an increasingly important environmental consideration.

Slurry - Vegetational Characteristics

Of the 53 slurry sites surveyed, almost one-half (25 sites) were barren. Early successional stages were present on all vegetated slurry sites, except two, where forest successional stages were present (Figure 13). Vegetation was often restricted to the perimeter of slurry areas (17 sites). Uniform distribution of vegetation occurred on eight sites; three sites supported vegetation in the center of the refuse areas. Ground cover density was barren to sparse on 36 sites (371.7 acres), poor on 10 sites (295.2 acres), fair to moderate on 2 sites (7.7 acres), and good on only 4 sites (19.2 acres) (Table 11). Invasion by naturally occurring species such as broom-sedge, phragmites (*Phragmites australis*), japanese honeysuckle (*Lonicera japonica*), and blackberry was recorded at 24 sites; only 2 sites supported both planted and natural vegetation. The two slurry areas supporting domestic vegetation were located at the New Kathleen Mine in Perry County where an experimental vegetation program had been conducted.

Broom-sedge was the most frequently recorded ground cover species on slurry refuse areas. Phragmites was an important dominant species

of moist slurry sites as compared to broom-sedge which occurred on dry sites. Broom-sedge and phragmites were dominant on 57.7 percent of the slurry refuse areas supporting ground cover vegetation (Figure 14).

Overstory vegetation was observed on 10 slurry sites, only 2 of which supported overstory densities greater than 10 percent. Natural overstory species occurred on all 10 sites, with 2 sites supporting trees greater than 6.0 inches DBH. Pin oak was the dominant overstory species on six sites, followed by black willow (Salix nigra) on three sites, and black locust (Robinia pseudoacacia) on one site (Figure 17).

The percentage of vegetated slurry areas (52.8 percent) was lower than that of vegetated gob areas. Also, the average size of slurry areas (13.3 acres) was larger than gob areas (5.7 acres), making invasion by naturally occurring species more difficult. Slurry areas are a result of relatively recent coal processing techniques, occurring at mines closed at a later date than many mines exhibiting only gob refuse piles. Consequently, vegetation on most gob areas had a longer period of time to become established.

Similar to gob, abandoned slurry areas also exhibited harsh growth medium conditions for vegetation establishment. Analysis of 52 slurry samples revealed low pH values, high concentrations of soluble salts, and acid-producing potential (Table 12). Nineteen percent (10) of the slurry samples had pH values greater than 4.0. Soluble salt concentrations in excess of 4,000 micro-mhos/cm were reported for 35 percent (18) of the samples. The average potential acidity for slurry (187 meq H^+/100 g) would require a maximum of 94 tons of lime per acre for neutralization.

Tipple - Physical Characteristics

Abandoned mine sites, unless they were small, usually included a tipple site where buildings and mine openings were located. Tipple sites were inventoried separately from gob and slurry refuse areas except when gob was deposited on the tipple area, in which case the disturbed acreage was recorded as gob acreage. Although abandoned tipple areas were not as great a pollution problem as gob and slurry refuse areas, their appearance was often aesthetiaally displeasing. Also, unsealed mine openings on the tipple areas represented a potentially hazardous condition.

A total of 813.2 acres was recorded for tipple areas occurring in 37 counties (Table 3). These areas ranged from 0.1 to 51.0 acres at 192 sites and averaged 4.2 acres. Six counties, Franklin (246.1 acres), Williamson (103.0 acres), Saline (82.6 acres), Macoupin (54.4 acres), Montgomery (52.7 acres), and Perry (45.9 acres), contained 71.9 percent of the tipple acreage recorded. The largest abandoned tipple site, located in Montgomery County, was being utilized as a maintenance shop by the Freeman United Coal Mining Corporation. Buildings remained at nearly two-thirds (124 sites) of the abandoned tipple sites. Buildings included machine shops, office buildings, wash houses, and tipples. Tipples at older sites were usually small wood frame structures, whereas the larger tipples at recently abandoned sites were often constructed of metal and concrete. Although over three-fourths (149 sites) of the tipple sites surveyed had fewer than four buildings remaining, eight sites had nine or more buildings intact. Foundations and discarded machinery were also recorded on tipple sites. Of the 192 tipple sites

surveyed, only 28 did not exhibit debris from the mining operations.

Roads totaling 26 miles were present on 79 abandoned tipple sites; over one-half (15 miles) consisted of tightly compacted gob refuse. Gravel was used for road construction at 24 tipple sites, while dirt and miscellaneous materials were noted at 11 sites. A paved road surface was recorded at one site. Most railroad spurs leading to tipple sites had been removed; only 7.5 miles of track were recorded at 19 abandoned tipple sites.

Potentially hazardous openings, defined as unsealed openings into the mine works, and openings flooded or partially filled with debris were recorded at 52 mines. Hazardous openings included main shafts, air and escape shafts, as well as slope and drift openings (Figures 20 and 21).

Erosion was usually not a problem on tipple areas due to their level topography and relatively heavy vegetative cover. Sheet erosion was the prevalent erosion condition observed (164 sites). Rill and gully erosion were recorded at only 28 sites.

Unauthorized dumping, observed at 25 sites, was the most frequently observed use of abandoned tipple sites. Productive uses of tipple sites, other than dumping and pasture for livestock, included the use of abandoned buildings as barns, repair shops, machine shops, and warehouses (Figure 22). Unusual uses included a gift shop and a home.

Disturbed land (813.2 acres) associated with abandoned tipple sites accounted for only 11.7 percent of the total acreage disturbed by abandoned underground mines (Figure 10). Although most of the disturbed land on tipple sites was well vegetated, some areas exhibited sparse vegetation

Figure 20. A partially flooded opening at a slope mine abandoned in 1939 in Williamson County represented a potentially hazardous situation.

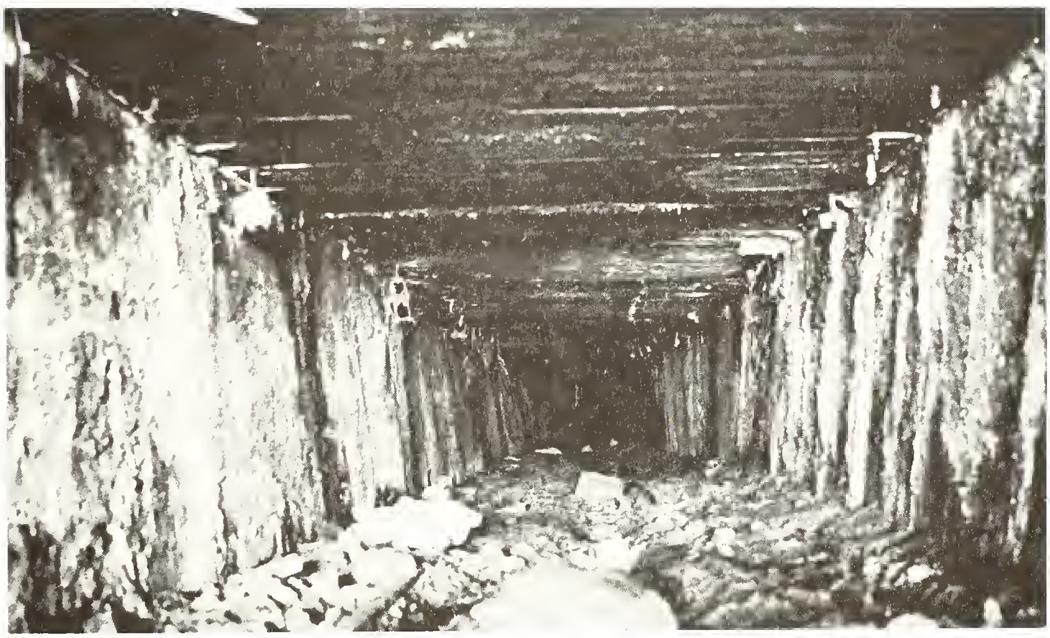

Figure 21. An unsealed slope entrance extends to the No. 6 seam which occurs at a depth of 100 feet at this abandoned mine in Williamson County.

due to drainage and sedimentation from adjacent refuse areas (Figure 23). Most abandoned tipple sites represented disturbed land which can be placed into productive use with a minimum of reclamation effort by sealing hazardous openings, removing mining debris, and eliminating drainage from adjacent refuse areas. Also, conversion of structurally sound buildings to productive uses can continue to be a valuable reclamation objective.

Tipple - Vegetational Characteristics

Similar to gob refuse sites, the most frequently occurring successional stage on tipple sites was herbs, shrubs, and small trees, which occurred at 79 sites (404.7 acres). Early invaders characterized 54 sites (199.2 acres), and 49 sites (60.2 acres) were forested (Figure 13). Distribution of vegetation was uniform at 89 sites (46.4 percent), scattered at 72 sites (37.5 percent), and confined to the perimeter of 8 sites (4.2 percent). Twenty-three (12.0 percent) tipple sites were barren; density of ground cover ranged from 10 percent or less at 41 sites (205.3 acres) to over 75 percent at 57 sites (146.9 acres). Poor ground cover (11 to 25 percent) was recorded at 17 sites (148.1 acres); 31 sites (125.5 acres) showed fair to moderate vegetative cover with densities ranging from 26 to 50 percent; and good vegetative cover (51 to 75 percent) was present at 46 sites (187.4 acres) (Table 11).

Unlike the sparsely vegetated gob and slurry areas, dense, uniformly distributed vegetative cover similar to that of adjacent undisturbed areas characterized many tipple sites. Well-vegetated tipple areas,

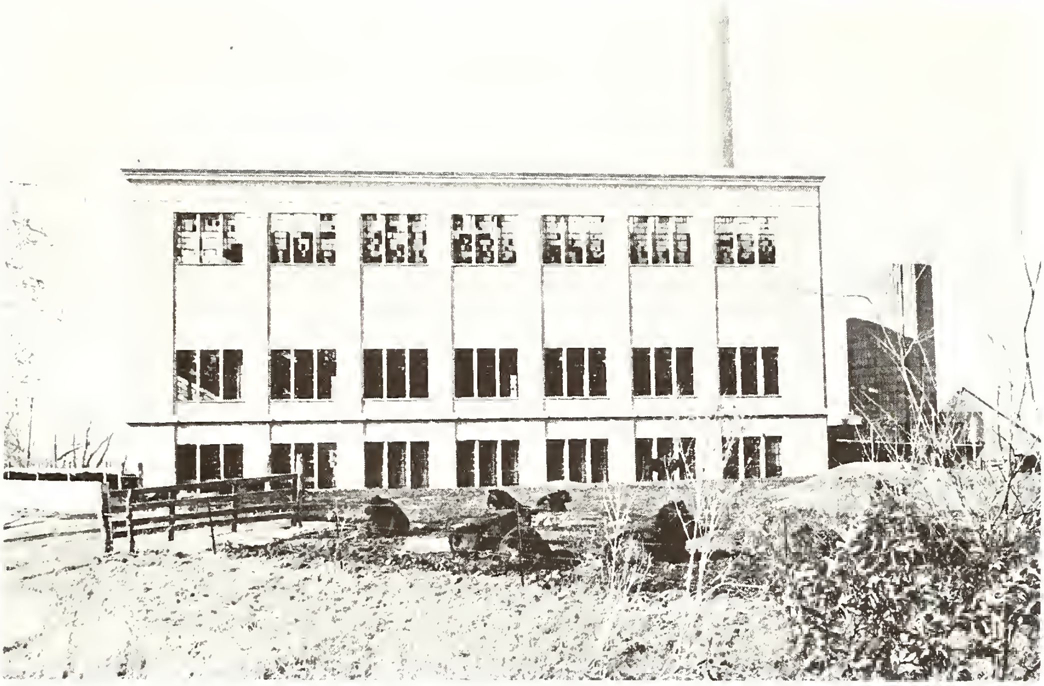

Figure 22. Structurally sound abandoned mine buildings were often utilized as barns, repair shops, and warehouses. (Photo by M. J. Sweet)

Figure 23. Sedimentation from an adjacent refuse area has adversely affected vegetation at this abandoned tipple area in Madison County.

identified as being distinct from refuse areas, were usually associated with large shipping class mines. Such mines had many buildings including machine shops, offices, wash houses, and coal preparation facilities, These facilities were surrounded by vegetation and separated from refuse, storage and loading areas. Consequently, revegetation of the entire tipple site was enhanced by the proliferation of existing vegetation. Invasion by naturally occurring species accounted for vegetation on most tipple areas; however, 10 sites exhibited both planted and natural species, and 7 sites were vegetated only by planted species. Planted ground cover species included fescue, lespedeza, and sweet clover (Melilotus spp.). Blackberry was the most frequently recorded dominant ground cover plant; other dominant ground cover species included broom-sedge, three-awn grasses, fescue, and sweet clover (Figure 14).

Overstory vegetation was more abundant on tipple than gob or slurry areas. Elm, wild cherry, box elder, and cottonwood were most frequently recorded as dominant overstory species (Figure 17).

Water Impoundments

Impoundments were originally constructed at deep mine sites to supply water to wash houses used by mine personnel. With the advent of coal washing and separating facilities at deep mines, larger impoundments were constructed to supply water for preparation plants (Figure 24). Water supplies usually were not associated with early small-scale mining operations. A total of 109 impoundments were recorded at 89 abandoned mine sites; 73 mines yielded 1 impoundment, 12 mines 2 impoundments,

and 4 mines 3 impoundments. On-site impoundments, which totaled 647.7 acres, ranged in size from 0.1 to 56.3 acres (average of 5.8 acres) (Table 3).

Although many impoundments were adjacent to, or surrounded by mine refuse areas, they were protected from mine drainage by embankments. Drainage from various mine refuse sources was received by only 44 impoundments: 34 received drainage from gob refuse, 8 from the general mine area, and 2 from slurry refuse. Industrial sources other than mine wastes were responsible for drainage into two impoundments; dumping accounted for pollution of two additional impoundments. The source of pollution for one impoundment was undetermined. Of the 49 impoundments with a pollution input, 36 were considered potential problem impoundments. These impoundments totaled 197.5 acres and were located in 19 counties (Appendix I).

At the time of the survey, 23 impoundments were used for recreational purposes such as waterfowl hunting, fishing, and swimming. Two impoundments were subjected to unauthorized dumping; one impoundment was used in a carbon recovery operation.

Of 76 impoundments with vegetation, 73 supported emergent, 16 floating, and 11 submergent vegetation. The number of impoundments actually supporting vegetation may have been higher as some impoundments were surveyed during winter months when aquatic plant growth was not readily apparent. This was particularly true for impoundments which may have accomodated floating and submergent vegetation such as duckweed (*Lemna* spp.) and coontail (*Ceratophyllum demersum*). Cattail (*Typha latifolia*) was the dominant species in nearly one-third (32.9 percent)

Figure 24. A 21-acre impoundment supplied water for coal processing at this abandoned mine which operated from 1904 to 1957 in Madison County.

Figure 25. Dense stands of phragmites (Phragmites australis) occurred around the moist perimeter of a water impoundment in Williamson County.

of the water impoundments yielding vegetation. Willow, occurring along impoundment edges, was identified as the dominant species for 23.7 percent of the vegetated impoundments. Although dominant at only three sites, phragmites occurred in dense stands around the perimeter of impounded areas (Figure 25). Other species observed included water lilies (Nelumbo lutea and Nuphar advena), water willow (Justicia americana), water primrose (Jussiaea repens), duckweed, pondweed (Potamogeton spp.), and smartweed (Polygonum spp.). Although 60 impoundments showed no pollutional input, 76 impoundments supported vegetation, indicating that pollution for at least 16 impoundments was not sufficiently severe to exclude plant growth.

Any reclamation plan for abandoned mine sites should consider the recreational potential of impoundments. Many water areas have recreational potential although they are currently receiving drainage from an adjacent refuse area. The 60 unpolluted water impoundments associated with abandoned underground mines represented an immediate recreational opportunity. Water quality of impoundments currently receiving drainage from adjacent refuse areas could readily be improved by diverting or impounding drainage on the refuse area.

Off-site Affected Areas

In addition to on-site disturbance associated with refuse and tipple areas, many mines produced off-site disturbance on adjacent terrestrial and aquatic areas. Off-site affected terrestrial areas were usually barren or sparsely vegetated due to toxic drainage or sedimentation from adjacent refuse areas. Off-site affected aquatic areas included adjacent

ponds, impoundments, and poorly drained stagnant water areas which received and held runoff from mine sites. Twenty-two off-site aquatic areas and 131 off-site terrestrial areas were identified (Table 3). Affected terrestrial areas, ranging from 0.1 to 73.0 acres, covered a total of 821.5 acres and averaged 6.3 acres. Affected aquatic areas totaling only 36.2 acres ranged from 0.1 to 10.0 acres and averaged 1.6 acres.

Although off-site affected areas accounted for only 857.7 (12.3 percent) of the total (6,955.9) disturbed acres (Figure 10), they represent an important aspect of reclamation planning. As off-site affected areas are not pollution sources but a result of problems associated with on-site conditions, the containment of the on-site source would return many off-site affected areas to productive use. However, abatement of the on-site source should be the ultimate reclamation objective.

Potential Problem Areas

The identification of potential problem sites associated with abandoned underground mines entailed an evaluation of the extent and severity of all adverse environmental parameters. Approximately 5,000 acres representing 508 mine sites located in 50 counties were identified as potential problem areas (Figure 26 and Appendix I). Problem areas reflected one or more of the following conditions (Figure 27):

1) Exposed refuse materials (2,846.6 acres of gob and 666.8 acres of slurry)

2) Abandoned tipple areas (432.8 acres)

3) Polluted water impoundments (on-site and off-site) (233.7 acres)

4) Adjacent, affected terrestrial areas (821.5 acres)

5) Mine drainage to adjacent ditches, streams, and/or rivers (276 mine sites)

6) Potentially hazardous mine openings including openings with mine drainage (70 mine sites).

Mine sites identified as potential problem areas ranged in size from 0.1 to 206.2 acres; however, 43 percent of the problem sites were less than 2.0 acres. Eight southern counties, Franklin (937.5 acres), Williamson (707.1 acres), Saline (362.9 acres), Macoupin (421.0 acres), Perry (269.9 acres), Madison (268.7 acres), St. Clair (261.6 acres), and Randolph (206.5 acres), contained more than two-thirds (68.7 percent) of this acreage (Figure 26, Appendix I). In addition, two northern counties (Bureau and Grundy) and one east central county (Vermilion) contained over 541.5 such acres. Deeply eroded refuse areas, as well as potentially hazardous or flowing openings, characterized the most severe problem conditions.

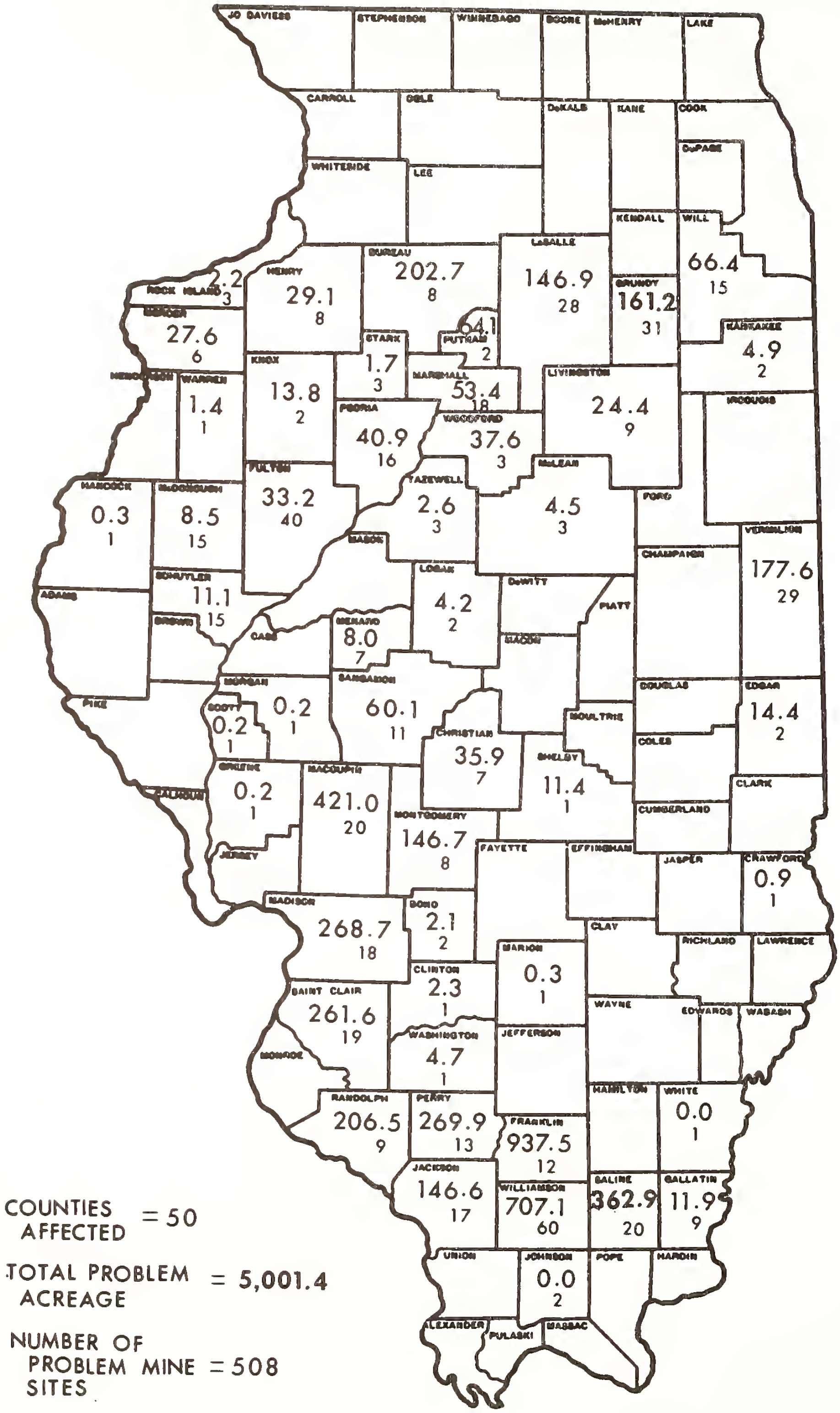

Figure 26. Total potential problem acreage for abandoned underground coal mines and number of potential problem mine sites in Illinois as of 1 September 1976. Large numerals represent county acreage; small numerals represent the number of problem mine sites.

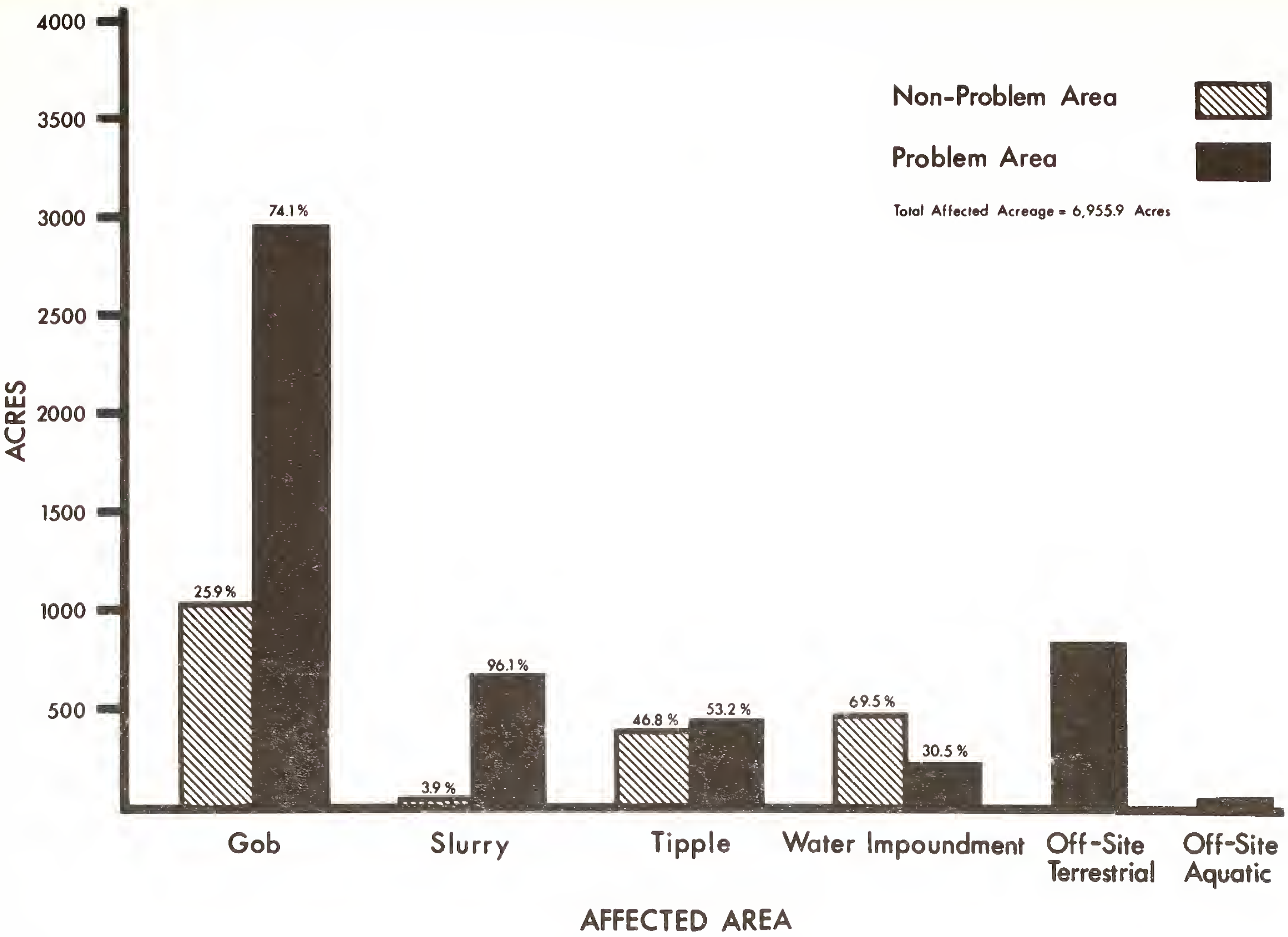

Figure 27. Potential problem and non-problem acreage of gob, slurry, and tipple areas, water impoundments, and off-site terrestrial and aquatic areas associated with abandoned underground coal mines in Illinois as of 1 September 1976.

Sites categorized as potential problem areas were usually sparsely or poorly vegetated (estimated vegetative cover of less than 25 percent) and classified as early invaders (grasses and herbs), or herbs, shrubs, and small trees. Ground cover vegetation on these sites was restricted to small clumps scattered over the area; common species included broom-sedge, three-awn grasses, and blackberry. Problem gob and slurry areas usually lacked overstory vegetation, or when it occurred, only a few stunted trees such as pin oak and elm were present. In contrast, sites not so designated generally exhibited vegetative cover ranging from good to excellent (estimated vegetative cover from 51 to 75 percent) with a variety of species.

The intention of the Illinois Abandoned Mined Lands Reclamation Act was to reclaim and restore to productive use mine sites designated as problem areas. Further, acquisition priorities for problem sites were to emphasize the degree of land, air or water pollution resulting from the condition of the land. To accomodate this, an objective system of ranking problem sites was developed (Appendix J and K). The system reflects an evaluation of the extent and severity of individual problem conditions and assignment of corresponding problem index points. A total problem index value was then calculated for the entire mine site. Problem index values should be useful in establishing reclamation priorities for all problem mine sites.

The number of abandoned underground mine sites considered to be potential problem areas (508) was small in comparison to the total number of abandoned mines recorded (4,076); however, potential problem sites represented a significant portion (71 percent) of the 711 mines with

evidence of past mining. Although small disturbances were often recorded as potential problem sites, they also represented a reclamation challenge that should not be ignored.

Mine Drainage

Drainage from refuse areas and old mine workings represents the most serious problem associated with abandoned underground mines. Although acid discharges from abandoned underground non-coal mines have been documented in the Rocky Mountain states and other mining areas of the United States, acid mine drainage is more severe and extensive in the coal mining regions east of the Mississippi River (Scott and Hays 1975). The U. S. Fish and Wildlife Service reported that 5,890 miles of streams and 14,967 acres of impoundments were adversely affected by acid mine drainage (Kinney 1964). More than 90 percent of this pollution was attributed to coal-mining operations.

Scott and Hays (1975) defined mine drainage as ground or surface water draining or flowing from, or having drained or flowed from, a mine or area affected by mining activities. Acid mine drainage is generally characterized by low pH, net acidity, high sulfate, high iron, and significant concentrations of aluminum, calcium, magnesium, and manganese (Hill 1968). Drainage quality and quantity depend on properties of the coal mined, mining method, reclamation, mine age, local geology, presence of bacteria associated with acid mine drainage, hydrology, and climatic conditions. Based on Federal Water Pollution Control Administration studies (Hill 1968), mine drainage has been grouped into four general classes ranging from neutralized to acidic (Table 13).

Acidic conditions associated with coal mine drainage result primarily from the oxidation of iron sulfide materials. Pyrite (FeS_2) is the most widespread and abundant sulfide mineral known, and, because of its abundance in eastern United States, it is the primary source of acid

Table 13. Mine drainage classes (Hill 1968:8).

	Class 1 Acid Discharges	Class 2 Partially Oxidized and/or Neutralized	Class 3 Oxidized and Neutralized and/or Alkaline	Class 4 Neutralized and Not Oxidized
pH	2 - 4.5	3.5 - 6.6	6.5 - 8.5	6.5 - 8.5
Acidity, mg/1 ($CaCO_3$)	1,000 - 15,000	0 - 1,000	0	0
Ferrous Iron, mg/1	500 - 10,000	0 - 500	0	50 - 1,000
Ferric Iron, mg/1	0	0 - 1,000	0	0
Aluminum, mg/1	0 - 2,000	0 - 20	0	0
Sulfate, mg/1	1,000 - 20,000	500 - 10,000	500 - 10,000	500 - 10,000

mine drainage.

As a result of the mining process, pyrite comes into contact with oxygen and water and is oxidized; subsequently, four equivalents of acid are released for each mole of FeS_2. The over-all equations for pyrite oxidation as described by Singer and Stumm (1970) are:

$$FeS_2(S) + 7/2\ O_2 + H_2O = Fe^{+2} + 2SO_4^{-2} + 2H^+ \quad (1)$$

$$Fe^{+2} + 1/4\ O_2 + H^+ = Fe^{+3} + 1/2\ H_2O \quad (2)$$

$$Fe^{+3} + 3H_2O = Fe(OH)_3(S) + 3H^+ \quad (3)$$

$$FeS_2(S) + 14Fe^{+3} + 8H_2O = 15Fe^{+2} + 2SO_4^{-2} + 16H^+ \quad (4)$$

Oxidation of S_2 of pyrite to sulfate releases ferrous iron and acidity into water (1). Subsequently, dissolved ferrous iron loses an electron to form ferric iron (2), which hydrolizes to insoluble ferric hydroxide and releases three equivalents of acidity (3). Pyrite can also reduce ferric to ferrous iron (4) releasing acidity and sulfate. Ferrous iron can then re-enter the reaction cycle at equation 2. Singer and Stumm (1970) found the rate determining step for acid formation to be ferrous iron oxidation, equation 2; therefore, they suggested effective control measures must be directed toward the catalytic oxidation of ferrous iron.

It is well known that the acid production rate can be accelerated many times its basal rate by activity of autotrophic iron-oxidizing bacteria (Silverman and Ehrlich 1964). Singer and Stumm (1970) compared ferrous iron oxidation rates in sterile and inoculated mine water; they found microbial mediation accelerated equation 2 by a factor larger than 10^6. The rate of equation 2 is too slow in the absence of a microbial catalyst to be of consequence in acid production

(Singer and Stumm 1970); thus, iron-oxidizing bacteria are essential to voluminous production of acid mine drainage.

Mine Drainage - Physical Characteristics

Surface drainage from, and percolation of water through mine refuse piles and exposed coal seams are the principal sources of mine-related water pollution in Illinois (Schleuger 1975). Gob refuse areas absorb large quantities of water during periods of prolonged rainfall, and subsequently release continuous or intermittent effluent. In contrast, drainage problems of eastern coal fields reflect continuous drainage from abandoned mine workings.

Severity of the mine drainage problem depends on the quantity and quality of the effluent being released. Continuous and/or intermittent runoff from refuse areas can destroy stream biota, increase turbidity, and place severe restrictions on utilization of a water resource. Previous estimates indicated 400 miles of streams and rivers in Illinois received mine drainage with over one-half the total concentrated in southern Illinois. Mine drainage to these waterways has, in varying degrees, adversely affected aquatic life (Schleuger 1975).

Mine drainage from the leaching of oxidized pyritic materials in the exposed refuse piles, overflow from acid pools on refuse areas, and continuous drainage from abandoned underground workings was recorded at 549 sites in 54 counties. Nine counties, Williamson (52 sites), Fulton (33 sites), Grundy (31 sites), Vermilion (30 sites), La Salle (28 sites), McDonough (28 sites), Macoupin (25 sites), Madison (22 sites), and Peoria (21 sites), contained almost one-half (49.2 percent) of the mine drainage sites. However, potential problem drainage, which was

characterized as affecting off-site areas, was delineated at only 343 sites in 40 counties. Six counties, Williamson (48 sites), Fulton (34 sites), Grundy (30 sites), Vermilion (26 sites), Saline (19 sites), and St. Clair (19 sites), contained over one-half (51.3 percent) of the sites with potential problem drainage.

Flow types were delineated as: 1) no apparent, 2) general runoff, 3) continuous pools and springs, and 4) other. General runoff was recorded at 502 sites. Continuous drainage was identified at 42 sites, including 23 sites where drainage was associated with abandoned underground workings; and 19 sites represented intermittent seepage from rain soaked gob refuse.

Mine drainage sources were delineated as: 1) gob only, 2) slurry only, 3) mine openings, and 4) general mine area. Intermittent drainage from gob only was recorded at 452 sites. Continuous drainage into adjacent waterways, recorded at 21 sites in 14 counties, originated from abandoned slope or drift mines along creek or stream banks. Seventeen of the 21 sites with continuous drainage from abandoned underground workings were concentrated in northern counties; Fulton (4 sites), Vermilion (3 sites), and La Salle (2 sites) contained 43.0 percent of such sites.

Although mine drainage conditions existed at 549 on-site areas, drainage to off-site areas was recorded at 435 sites. Off-site affected areas included: 1) ditches, creeks, and streams, 2) farm ponds, and lakes, and 3) terrestrial areas. Direct drainage to adjacent waterways was recorded at 281 sites. Drainage from large, exposed refuse areas and continuously flowing openings provided a major source

of small stream flow in several central and northern counties (Figure 28). Other off-site areas receiving drainage included 135 terrestrial sites and 19 impoundments.

Iron hydroxide precipitate ("yellow boy") up to 6 inches deep was observed in streams adjacent to refuse piles or flowing openings. At several mines, drainage effects were observed up to 1.5 miles from the source. Continuously flowing effluent from the Thomas Osborn No. 1 Mine in Saline County and a coal prospecting drill hole in Gallatin County had destroyed approximately 4 acres of forested vegetation in the Shawnee National Forest (Figure 29). The unsealed prospect hole had apparently penetrated abandoned underground mine workings. Productivity of agricultural fields and pastures were also adversely affected, particularly when row crops were planted adjacent to refuse areas.

Mine Drainage - Chemical Analysis

In addition to identifying potential mine drainage sources, flow types, and associated affected areas, chemical parameters of mine drainage were evaluated. A total of 500 samples was collected from waters on and adjacent to preparation sites at 245 abandoned mines in 41 counties. Ten major sample types were collected (Table 14). Above Mine samples, representing adjacent flowing waters before mine drainage influence, were collected upstream from the mine area. Where drainage from a mine site represented stream headwaters, no Above Mine sample was available. General Runoff was classified as water in ditches and gullies originating on the mine area and flowing into adjacent waters or terrestrial areas (Figure 30). Below Mine samples, representing

Figure 28. Drainage from large abandoned refuse areas often entered adjacent streams.

Figure 29. Drainage from abandoned mine workings has destroyed approximately 3 acres of forest vegetation in the Shawnee National Forest in Saline County.

Table 14. Chemical-statistical data for 500 water samples collected from 245 abandoned underground mine sites in Illinois.[a]

Sample Type	pH	Total Fe mg/l	SO_4^{-2} mg/l	Soluble Mn mg/l	Total Acidity mg/l as $CaCO_3$	Conductivity micro-mhos/cm	Soluble Al mg/l
Above Mine (60)[b]							
Median	7.4	0.90	330	0.0	9	800	0.2
Mean	6.9	19	820	8.0	50	1300	3.5
SD	1.47	82.7	2830	48.8	137	2770	13.5
Min	2.5	0.12	45	0.0	0	240	0.0
Max	8.4	620	22000	378	750	22000	92
General Runoff (110)							
Median	3.0	57	1300	6.4	415	2900	37
Mean	3.5	510	5200	21	3200	5100	240
SD	1.54	1260	10780	31.1	6450	6300	513
Min	1.6	0.36	31	0.0	4	180	0.1
Max	7.8	10000	89000	145	39300	32000	3100
Below Mine (139)							
Median	6.3	5.0	630	1.8	50	1350	0.8
Mean	5.4	130	1800	6.1	880	2100	75
SD	2.10	363	4850	10.2	3270	2400	285
Min	2.2	0.12	21	0.0	0	97	0.0
Max	8.5	2800	41000	75	27800	17200	2500
Gob Pools (41)							
Median	2.6	100	1600	4.1	960	2700	53
Mean	3.2	430	3900	17	3500	4200	200
SD	1.47	870	5710	34.2	6410	3870	336
Min	1.8	0.49	210	0.0	6	390	0.1
Max	7.8	4000	26000	200	24200	16500	1500

Table 14. Continued.

Sample Type	pH	Total Fe mg/l	SO_4^{-2} mg/l	Soluble Mn mg/l	Total Acidity mg/l as $CaCO_3$	Conductivity micro-mhos/cm	Soluble Al mg/l
Slurry Pools (21)							
Median	2.4	100	2400	8.2	990	4100	82
Mean	3.0	510	3500	14	2600	4400	170
SD	1.51	902	2970	18.6	3060	3030	300
Min	2.0	0.39	320	0.0	6	1110	0.1
Max	7.6	4000	10400	65	9700	14600	1300
Flooded Openings (7)							
Median	6.6	4.5	1100	1.3	31	2900	1.0
Mean	6.3	28600	1600	5.9	690	2600	8.4
SD	1.47	75590	1690	11.7	1640	1865	18.4
Min	4.1	0.57	290	0.0	7	610	0.0
Max	7.7	200000	5100	32	4400	6000	50
Flowing Openings (25)							
Median	6.4	52	1600	2.0	105	2700	2.2
Mean	5.5	160	3400	17	720	3900	81
SD	1.80	221	8150	65.4	1410	5550	300
Min	2.4	0.88	330	0.0	24	750	0.0
Max	7.4	730	42000	330	6100	30000	1500
On-site Impoundments (56)							
Median	7.2	0.88	260	0.0	16	760	0.3
Mean	6.3	94	1100	4.4	560	1460	33
SD	2.16	320	2110	9.42	1630	1654	102
Min	2.0	0.11	41	0.0	0	10	0.0
Max	9.6	1600	9900	45	7700	6800	540

Table 14. Continued.

Sample Type	pH	Total Fe mg/l	SO_4^{-2} mg/l	Soluble Mn mg/l	Total Acidity mg/l as $CaCO_3$	Conductivity micro-mhos/cm	Soluble Al mg/l
Off-site Aquatic Areas (14)							
Median	7.6	0.72	220	0.0	6	560	0.2
Mean	7.1	2.71	410	0.5	20	720	1.5
SD	1.83	5.95	410	0.89	49.4	512	3.24
Min	2.8	0.04	47	0.0	0	79	0.1
Max	9.1	23	1400	2.3	190	1710	12
Off-site Terrestrial Areas (27)							
Median	2.8	18	1100	8.2	340	2100	37
Mean	3.3	410	3300	16	2000	3400	150
SD	1.38	1260	5560	22.0	3960	3540	243
Min	1.8	1.30	100	0.0	14	240	0.2
Max	6.9	6500	24000	109	16700	15300	970

[a]Data have been rounded to levels of significance compatible with precision and accuracy.

[b]Numbers in parentheses indicate the number of samples analyzed per sample type.

downstream waters after mine drainage influence, were collected an appropriate distance below the confluence of mine waters with adjacent waters to allow mixing. Depressions on gob and slurry areas capable of holding temporary or permanent water between periods of rainfall were classified as Gob or Slurry Pools. Samples identified as Flooded or Flowing Openings were distinguished by the presence or absence of effluent. On-site Water Impoundment samples were collected from permanent ponds located on the mine property (Figure 31). Water samples were also collected from adjacent Off-site Aquatic Areas (farm ponds, lakes, etc.) which appeared to be receiving pollutional discharges and Off-site Terrestrial Areas on which mine drainage had formed stagnant pools.

Results of analyses were compared to IPCB mine effluent criteria and IPCB general water standards to determine water quality associated with these areas on a state-wide basis (Table 15). Off-site waters should have complied with IPCB general standards; On-site waters, including General Runoff, should have complied with IPCB mine effluent criteria and applicable general water quality standards. On-site waters were assumed to meet mine effluent criteria as these waters had effluent potential through erosion, underground seepage, runoff, flooding, and overflow.

IPCB general water quality standards were intended to protect the state's water for aquatic life, agricultural uses, primary and secondary contact use, and most industrial uses; and to ensure the aesthetic quality of the state's aquatic environment (Illinois Pollution Control Board 1976). The IPCB mine effluent criteria were established to

Figure 30. General runoff was identified as water in ditches and gullies originating on the mine area and flowing into adjacent waters or terrestrial areas.

Figure 31. Adjacent water impoundments were often adversely affected by drainage from barren refuse areas.

Table 15. Contamination levels of acid, iron, manganese, pH, and sulfate established for Illinois mine effluent and general waters.

Constituent	Effluent Criteria[a] mg/l	General Standards[b] mg/l
Acid	(total acid shall not exceed total alkalinity)	-
Iron (total)	7	1.0
Manganese (total)	-	1.0
pH	5 - 10	6.5 - 9.0
Sulfate	-	500

[a]Illinois Pollution Control Board Rules and Regulations: Chapter 4, Mine Related Pollution, 1972.

[b]Illinois Pollution Control Board Rules and Regulations: Chapter 3, Water Pollution, 1976.

prevent air and water pollution in Illinois caused by failure to plan proper environmental safeguards as to location, operation, and abandonment of mining and mine refuse areas (Illinois Pollution Control Board 1972). Mine effluent was defined as any mine wastewater discharged, directly or indirectly, to the waters of Illinois or to any storm sewer, and the runoff from land used for the disposition of wastewater or sludges (Illinois Pollution Control Board 1976).

Statistical data for water sample types are presented in Table 14. Large standard deviations and median-mean differences generally resulted from a few samples that exhibited unusually high or low values. Thus, medians were commonly more characteristic of samples than means.

Above Mine-- As anticipated, Above Mine samples represented generally unpolluted waters; most samples were within IPCB general standards (Table 15). Seventy-seven percent (46) of the samples collected were within the acceptable IPCB general standard range of 6.5 to 9.0 pH units. Forty-seven percent (28) of the total iron values exceeded the IPCB general standard (1.0 mg/l); 15 percent (9) exceeded the IPCB general mine effluent criteria (7 mg/l). Twenty-eight percent (17) of the samples had sulfate concentrations greater than the IPCB general standard (500 mg/l). Twenty-eight percent (17) contained soluble manganese concentrations greater than the IPCB general standard (1.0 mg/l); 38 samples (63 percent) contained no soluble manganese. Median total acidity was 9 mg/l; median conductivity was 800 micro-mhos/cm. Median soluble aluminum concentration for 23 locations was 0.2 mg/l.

With the exception of a few sites, Above Mine samples represented unpolluted aquatic habitats characterized by low total acidity, high pH values, and low metallic ion concentrations.

General Runoff-- Eighty-five percent (93) of the samples exhibited pH values less than the IPCB mine effluent permissible range (5.0 to 10.0 pH units); only 7 percent (8) were greater than 7.0. Sixty-eight percent (75) of the total iron values exceeded the IPCB mine effluent criteria (7 mg/l). As compared to Above Mine samples which exceeded the IPCB general standard for iron (1.0 mg/l) in 47 percent of the samples collected, 88 percent of the General Runoff samples exceeded this value. Seventy-three percent (80) of the samples had sulfate concentrations in excess of the IPCB general standard (500 mg/l). Soluble manganese exceeded the IPCB general standard (1.0 mg/l) in 77 percent (85) of the samples; 18 samples (16 percent) contained no manganese. Ninety-five percent (105) of the General Runoff samples had total acidities exceeding the median Above Mine value (9 mg/l). Soluble aluminum exceeded the median Above Mine value (0.2 mg/l) for 93 percent (102) of the General Runoff samples. Eighty-five percent (93) of conductivities exceeded the median Above Mine value (800 micro-mhos/cm) indicating that large concentrations of iron, sulfate, manganese, and aluminum were present in General Runoff from refuse areas.

Although General Runoff water quality varied greatly, the majority of samples were viewed as Class 1 and 2 mine drainage (Table 13) with discharges in excess of IPCB mine effluent criteria. The lowest pH, and highest sulfate, acidity, conductivity, and soluble aluminum values

of any sample type were recorded for General Runoff (Table 14). The median acidity of General Runoff (415 mg/l) was about 46 times as acidic as Above Mine waters. The median pH (3.0) was sufficiently low to allow large concentrations of metallic ions to be leached into the water. Large differences in median total acidity and pH of Above Mine samples as compared to General Runoff samples emphasized the toxicity of drainage from abandoned refuse areas. Faunal and floral diversity would be less in these environments than in Above Mine waters; only forms adapted to the severe conditions could survive these harsh conditions.

Below Mine-- Fifty-two percent (72) of the samples exhibited pH values less than the IPCB general standard range (Table 15). Only 29 percent (41) of the samples had a pH greater than 7.0. Seventy-seven percent (107) of total iron values exceeded the IPCB general standard; in addition, 47 percent (65) exceeded the IPCB mine effluent criteria. Although Below Mine waters are not expected to comply with IPCB mine effluent criteria, Below Mine values in excess of these criteria further emphasize the adverse influence of runoff from mine refuse areas. Sulfate concentrations exceeded the IPCB general standards for 63 percent (88) of the samples. Sixty percent (83) of the samples contained soluble manganese in excess of the IPCB general standard; 39 samples (28 percent) contained no soluble manganese. Seventy-nine percent (110) of total acidities exceeded the median Above Mine value. Seventy-three percent (107) of the Below Mine samples had soluble aluminum exceeding the median Above Mine value (0.2 mg/l). The influence of soluble

metallic ions and sulfate from mine drainage was apparent in Below Mine waters; 88 percent (111) of these samples had conductivities exceeding the median Above Mine value. Although there are no established IPCB general or mine effluent standards for aluminum in Illinois, the increase of soluble aluminum in Below Mine waters further illustrated the influence of mine drainage into adjacent waterways.

These data indicated that Below Mine samples, due to the adverse influence of mine drainage, were areas of poor water quality. Most Below Mine samples did not comply with IPCB general standards and may, for comparative purposes, be considered Class 2 or 3 mine drainage (Table 13).

In summary, the three major sample types (Above Mine, General Runoff, and Below Mine) illustrated the deterioration of water quality in response to mine drainage input. Below Mine waters appeared adversely affected by mine drainage for all parameters. Above Mine waters were generally highest for pH and lowest for other parameters; General Runoff was lowest for pH and highest for other parameters. Above Mine waters were relatively unpolluted for the parameters measured.

Gob and Slurry Pools-- Eighty-eight percent (36) of Gob Pools had pH values less than the lower limit of the IPCB mine effluent criteria (5.0); only one sample had a pH greater than 7.0. Gob Pools exceeded IPCB mine effluent criteria for total iron (31 samples, 76 percent) and IPCB general standards for sulfate (35 samples, 85 percent), and soluble manganese (31 samples, 76 percent). Also, total iron and acidity values for Gob Pools exceeded median General Runoff values almost twofold.

Conductivities exceeding the median Above Mine value were reported for 93 percent (38) of Gob Pool samples. Ninety percent (37) of soluble aluminum values also exceeded the median Above Mine concentration.

Ninety percent (19) of Slurry Pools had pH values less than the lower limit of the IPCB mine effluent criteria (5.0). Similar to gob, Slurry Pools also exceeded IPCB mine effluent criteria for total iron (17 samples, 81 percent), and IPCB general standards for sulfate (20 samples, 95 percent) and manganese (18 samples, 86 percent). Median Above Mine values were exceeded for total acidity (20 samples, 95 percent), conductivity (21 samples, 100 percent), and soluble aluminum (19 samples, 90 percent).

Pools on gob and slurry areas were chemically similar and in excess of IPCB mine effluent criteria and IPCB general standards. These waters, considered Class 1 mine drainage, reflected the acid producing potential of refuse areas (Table 13). Median total acidity for both Gob and Slurry Pools was more than 100 times as acidic as Above Mine waters.

Flooded and Flowing Mine Openings-- Two Flooded Mine Openings had pH values less than 5.0. Samples exceeded IPCB mine effluent criteria for total iron (3 samples, 43 percent) and IPCB general standards for sulfate (6 samples, 86 percent) and soluble manganese (4 samples, 57 percent).

Thirty-two percent (8) of Flowing Mine Openings had pH values less than 5.0. Samples exceeded IPCB mine effluent criteria for total iron (22 samples, 88 percent) and IPCB general standards for sulfate (23 samples,

92 percent) and soluble manganese (18 samples, 72 percent). Conductivities for 96 percent (24) of the Flowing Opening samples exceeded the median Above Mine value. Soluble aluminum also exceeded the median Above Mine value in 22 cases (88 percent).

The quality of water occurring on mine openings reflected a condition between drainage Classes 2 and 3. Although the quality was better than General Runoff and Gob or Slurry Pools, it was poorer than Above Mine waters. Flooded Openings usually complied with IPCB mine effluent criteria for pH and total iron but exceeded IPCB general standards for sulfate and soluble manganese. Flowing openings were usually within IPCB pH limits, but exceeded total iron, sulfate, and soluble manganese requirements. Median acidity for Flowing Openings was 10 times greater than the Above Mine median value. Although water quality of Flowing Openings was not as severe as that reported for General Runoff, the total pollutional impact might be greater in view of the continuous flow of this effluent source.

<u>On-site Impoundments</u>-- Only 25 percent (14) of On-site Water Impoundments had low pH values (less than 5.0); 52 percent (29) exceeded 7.0. On-site Impoundment samples exceeded IPCB mine effluent criteria for total iron in only 16 samples (29 percent), or IPCB general standards for sulfate in only 17 samples (30 percent) and soluble manganese in 23 samples (41 percent). Median values for total acidity (16 mg/l), conductivity (760 micro-mhos/cm), and aluminum (0.3 mg/l) of On-site Impoundments were similar to Above Mine values (Table 14).

<u>Off-Site Aquatic Areas</u>-- Seventy-one percent (10) of Off-site

Aquatic Area samples were within the IPCB general range for acceptable pH. Off-site Aquatic Areas exceeded IPCB general standards for total iron (5 samples, 36 percent), sulfate (4 samples, 29 percent), and soluble manganese (3 samples, 21 percent). Similar to On-site Impoundment samples, median values for total acidity, conductivity, and soluble aluminum compared favorably to Above Mine values (Table 14).

On-site Impoundment and Off-site Aquatic Area samples generally complied with IPCB mine effluent criteria and general standards. These waters were chemically similar to Above Mine waters for all parameters, as input also included drainage from unaffected watersheds. Except for a few sites, impoundments did not exhibit adverse affects of pollutional discharges when sampled. The majority of these waters would not be classified as mine drainage.

Off-site Terrestrial Areas-- Water collected from stagnant pools on Off-site Terrestrial Areas reflected the influence of mine drainage entering these areas. Stagnant pools on these areas usually resulted from mine drainage overflow and flooding.

All samples (27) of Off-site Terrestrial Areas had pH values less than 7.0 (Table 14). Also, all total iron concentrations exceeded the IPCB general standard. Adjacent terrestrial areas exceeded the IPCB general standards for sulfate (21 samples, 78 percent) and soluble manganese (24 samples, 89 percent). All total acidities exceeded the Above Mine median value. Most soluble aluminum values (26 samples, 96 percent) exceeded the Above Mine median. Similarly, conductivities exceeded the Above Mine median for most areas (22 samples, 81 percent), illustrating the adverse conditions.

All samples collected from Off-site Terrestrial Areas exceeded at least one IPCB general standard. Waters collected from these areas were considered Class 1 mine drainage.

Mine Drainage Summary

Analysis of mine drainage samples indicated water of poor quality is polluting Illinois waters and terrestrial areas. Water quality was within acceptable limits before reaching abandoned mine sites; however, due to drainage from refuse areas, a deterioration in quality was found in Below Mine waters. Although Above Mine, On-site Water Impoundment, and Off-site Aquatic Area samples generally complied with state standards, Below Mine, General Runoff, Gob and Slurry Pools, Flooded and Flowing Openings, and pools on Off-site Terrestrial Areas exceeded IPCB standards. Reclamation of abandoned refuse areas is of major concern as most on-site pollution eventually enters adjacent waters or terrestrial areas as general runoff. In addition to assessing the quality of runoff, determining the quantity will also be important in developing a reclamation plan for each mine site.

Assessment of Active Underground Mines

In addition to the 4,076 abandoned underground mines surveyed, 24 active underground mines located in 13 counties were identified. Active mines recorded in this survey included three mines not reported in the 1975 Illinois Department of Mines and Minerals Annual Coal Report. These included one mine previously listed as under construction in Macoupin County, one previously abandoned deep mine in Williamson County which was used to process and store coal supplied by a nearby active deep mine, and an auger mine in Vermilion County. Although no acreage was recorded for the auger mine, as it operated in association with a small surface mine, it was included in the survey due to its deep mine classification, as defined by the Illinois Pollution Control Board Regulations, Chapter 4: Mine Related Pollution (Illinois Pollution Control Board 1972).

All active underground mines were located in the central and southern counties. Total acreage reported for active mines (3,591.7 acres) varied from 10.0 to over 375.0 acres. The trend toward large mining operations is reflected when the total acreage recorded for 23 active mines (3,591.7 acres) is compared to the total affected acreage recorded for 700 abandoned mines (6,955.9 acres).

Gob refuse areas totaling 982.4 acres (average 40.9 acres) were recorded at 24 sites (19 mines). Refuse associated with underground mines at sites where volume calculations were applicable (16 sites) totaled 12.8 million cubic yards (average 799,600 cubic yards). Older mines which had been in operation for over 20 years most often exhibited extensive gob piles. These large refuse areas were graded and terraced to reduce erosion and drainage. As current regulations require grading,

covering, and revegetation of refuse piles within 1 year of abandonment, development of plans and procedures for effectively dealing with refuse disposal need to be formulated and implemented during the active mining operation. Consequently, newer mines had lesser amounts of refuse at the mine site. Current disposal practices included continuous burying and covering, as well as compacting, grading, and covering of refuse.

Slurry disposal sites totaling 693.6 acres were recorded at 28 sites (15 mines). Slurry impoundments at most mines were surrounded by tightly compacted embankments to prevent off-site drainage. Coarse refuse was used to construct embankments at several active slurry disposal areas. Similar to gob refuse, inactive slurry impoundments must also be graded and covered in accordance with current regulations.

Tipple areas totaling 841.9 acres were recorded at 24 mines. Unprocessed coal from two slope mines in Saline County was transferred via conveyer belts to a surface mine tipple area for processing. Two additional coal companies which operated both surface and underground mines used one tipple site to process coal from both of their mines.

Current emphasis on non-polluting refuse disposal systems incorporates closed system recycling for water used in the processing of coal (E. D'Appolonia Consulting Engineers, Inc. 1975). Consequently, most mines utilized more than one impoundment for fresh water supply as well as runoff retention basins. Twenty-five impoundments totaling 532.9 acres were recorded at 12 mines. Impoundments ranged from 0.9 to 90.0 acres, averaging 21.3 acres. In addition to their use in coal processing, many fresh water impoundments provided recreational opportunities as well.

The trend toward large mining operations coupled with increased emphasis on efficient land use will underscore the importance of returning areas affected by mining to a productive use. In this context, it will be essential for the mining industry to comply with all environmental regulations during the period of active mining and subsequent abandonment.

GENERAL COMMENTS

As a consequence of this study, Illinois reflects a unique position in having completed detailed inventories of all lands and waters affected by both surface and deep mining for coal. Both studies emphasized prelaw and postlaw conditions as referenced by state legislation (Surface-Mined Land Conservation and Reclamation Act, PA 78-1295) and regulations affecting the mining of coal and its impact on water quality (Illinois Pollution Control Board Regulations: Chapter 3, Water Pollution, and Chapter 4: Mine Related Pollution). Baseline data are now available permitting appraisal of the effectiveness of state regulations in ensuring quality environments during and following coal mining.

In contrast to the surface mine survey, the deep mine inventory identified primarily non-productive lands related to extraction and processing sites, namely those that were sources of pollution and which represented health and safety problems. Had it been possible to emphasize other impacts such as subsidence, idled transportation facilities and other "off-site conditions," a more complete analysis would have been available. In this respect then, the evaluation of the impact of surface mining was more complete because essentially all acreages affected were identified, including those which have been effectively reclaimed and returned to productive use. With the exclusion of "off-site factors," it is quite clear that surface mining has a much greater impact acreage-wise than deep mining. However, problem situations as related to sites of processing coal such as gob

and slurry are similar regardless of the techniques of extraction. The added dimensions of surface mining reflect the surface disturbance of land, need for haulage roads, and necessity to restore extensive acreages to productive use following handling and displacement of overburden materials.

Illinois, as a result of the two state-wide inventories, is now in the position to develop, as well as assist in the development of, state-wide coordinated planning to accomodate the problems created by the mining of coal. The surveys are of immense value to the Abandoned Mined Lands Reclamation Council so as to accomplish its charged responsibility of acquiring abandoned mined lands and restoring them to productive use (Illinois General Assembly 1975). Further, state, regional, county, and city planners now have available necessary information for their needs in planning not only for problem-site resolution but for future land use practices as these relate to each specific responsibility. With the specificity of information on the impact of coal mining available, the state as a whole, as well as its various political subdivisions, have a priority position with regard to participating in the sharing of state and federal funds. It seems apparent that monies will be available in the future as a result of actions by the Illinois legislature and U. S. Congress. It can be anticipated that certain conditions must be met for access to funds not the least of which may be a state-wide inventory, a plan for decision making in developing priorities, and identified objectives and alternatives for productive use of reclaimed sites.

The inventory data will permit reclamation planning in a way that

will emphasize coordination between political subdivisions, hence a responsiveness to not only community but also regional and state-wide needs and concerns. Seemingly such an approach will accomodate a prioritized systems approach emphasizing in its design the seriousness of the problem as well as the "value" of the end product of the reclaimed site. Essential then is the development of an acceptable means for decision making which is not impacted by special interests at any level. The Abandoned Mined Lands Reclamation Council ought to aggressively pursue the development of a model plan for arriving at priorities in reclamation. Such a plan, coordinated with selected state and federal agencies, is a necessity if Illinois is to not only meet its responsibility for prelaw conditions, but also participate fully in any programs of revenue sharing. Further, such a plan will also contribute to decision making at all political subdivision levels of the State.

As a final step in the inventory of deep mine sites, a site-specific directory is being developed. This will complement that assembled for surface-mined problem sites. Although this is not necessary for the evolvement of a state-wide decisioning process, it will establish the precise parameters of problem situations related to the site of extraction and processing of coal from underground mining.

Reclamation of areas affected by deep mining requires special considerations because of the critical nature of the problems. Other than costs, disposal of debris, removal of structures (or their renovation for other uses), or sealing an open shaft, present no special difficulty. However, gob, slurry, and contaminated sites are serious conditions for which fully satisfactory reclamation procedures

are not yet available. The physical and chemical characteristics of these affected areas have not been adequately addressed for there to be ready answers on how to return them to productive use or even an aesthetically acceptable condition. This situation, of course, is no different than that identified for coal processing sites associated with surface mining.

Attempts to resolve problem situations should include an appraisal of potential carbon recovery as an initial step. However, many gob disposal sites and slurry ponds have little or no possibility for such consideration because of inadequate recoverable carbon or an acceptable market. The most environmentally acceptable approach is the removal of the surface-stored materials either to be placed in mined-out areas (a possible reduction in subsidence problems), to be used as the core in a land fill for roadbed development, to provide ballast for sites where it is desireable to depress vegetation, or to be processed for removal of toxic qualities and used as fill or in construction. However, these ideas for utilization require the attention of technology. Industry and industrial park developers should give high priority to such sites to avoid removal of prime lands from other high priority uses. Also, it should be appreciated that community enhancement, aesthetically and economically, can be in this way specifically addressed.

It is recognized that gob, slurry, and other contaminated sites can be covered with acceptable soil and seeded to desired vegetation. However, one is then confronted with obtaining soil elsewhere to accomplish adequate covering which becomes impractical when prime agricultural land is involved. The development of a direct seeding

technique may provide limited answers to some sites; but, this is as yet experimental and seemingly successful plots have not stood the test of time. Evidence to date on covering with soil and seeding, as well as direct seeding, suggests that sites must be graded to a near level topography to minimize problems of erosion, leaching, and subsequent vegetation failure. At best such sites, as based on current techniques and results, are fragile environments, have questionable continuity as vegetated sites, and hence hold little potential for intensive use. They might best be considered a contribution to habitat for wildlife, which in many intensively farmed areas of Illinois would be an unusual practice to enhance wild animal distribution and populations. Aesthetically pleasing sites can be created which can afford limited recreational use, especially when associated with the development of marshes and open-pond areas.

There should be an aggressive effort to eliminate the occurrence of problem sites through plans that do not permit them in the first place. In other words, eliminate the problem rather than trying to hide it with costly reclamation practices. Surely this should be a challenge to mining technology and mining engineers equally as important as the extraction and processing of coal. This requires, however, full appreciation of the total responsibility as it relates to the coal extraction and its utilization.

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APPENDICES

APPENDIX A

FIELD DATA FORM FOR SURVEY OF ILLINOIS UNDERGROUND COAL MINES

Cooperative Wildlife Research Laboratory:
Survey of Illinois Underground Coal Mines

BIOGRAPHICAL DATA

Date: __________ Examiner: __________ County; __________
Township: ________ Range: ________ Section: ________ Part: ________
Mine index no.: __________ Mine name: __________
CWRL photo index no.: __________ Observable from photo: 1 2
Environmental locale: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Potential problem area status: 0 1
Exposed gob and/or slurry: 0 1 Tipple debris: 0 1
Open and/or water-filled shafts: 0 1
Mine drainage to adjacent areas: 0 1
Type of opening: 0 1 2 3 4
Area surface mined after deep mining: 0 1 2
Total affected area: __________ acres
Current ownership of affected surface area: ____________________

GOB - PHYSICAL CHARACTERISTICS

Gob no.: __________ Acres: __________
Active mining area: 0 1 2
Burn: 0 1 2 3 Amount burned: 0 1 2 3 4 5
Height: 0 1 2 3 4 5 6 7 8 9 Volume: __________ cubic yards
Average depth: __________
Slope: 0 1 2 3 4 5 Erosion: 0 1 2 3 4 Drainage: 0 1 2 3 4
Composition: 0 1 2 3 4 Fragment size: 0 1 2 3
Past treatment: 0 1 2 3 4 5 6 Present utilization: 0 1 2 3 4

GOB - VEGETATIONAL CHARACTERISTICS

Successional stage of gob vegetation; 0 1 2 3 4 5
Ground cover - Distribution: 0 1 2 3 4 5 Density: 0 1 2 3 4 5
Source: 0 1 2 3 Dominant species: ____________________
Overstory - Distribution: 0 1 2 3 4 5 Density: 0 1 2 3
Source: 0 1 2 3 Successional stage: 0 1 2 3 4
Dominant species: ____________________

SLURRY - PHYSICAL CHARACTERISTICS

Slurry pond no.: __________ Acres: __________
Active: 0 1 2
Surface water: 0 1 2

SLURRY - PHYSICAL CHARACTERISTICS (continued)

Erosion: 0 1 2 3 4 Drainage: 0 1 2 3 4
Past treatment: 0 1 2 3 4 Present utilization: 0 1 2 3 4

SLURRY - VEGETATIONAL CHARACTERISTICS

Successional stage of vegetation; 0 1 2 3 4 5 Distribution: 0 1 2 3
Ground Cover - Density: 0 1 2 3 4 5 Source: 0 1 2 3
Dominant species: ____________________

TIPPLE - PHYSICAL CHARACTERISTICS

Tipple no.: __________ Acres: __________
Active mining area: 0 1 2 3
No. of buildings: __________ No. of shafts: __________
Location: __________ No. of open and/or flooded shafts: __________
Type of open and/or flooded shaft: 0 1 2 3
No. of sealed shafts: __________ Year sealed: __________
Associated debris: 0 1 2 3 4
Roads (1/10 mi.): __________ Road surface: 0 1 2 3 4 5
Railroads (1/10 mi.): __________
Erosion: 0 1 2 3 4 Drainage: 0 1 2 3 4
Present utilization: 0 1 2 3 4 5
Same characteristics as gob: 000 999

TIPPLE - VEGETATIONAL CHARACTERISTICS

Successional stage of vegetation: 0 1 2 3 4 5 6
Distribution: 0 1 2 3 Density: 0 1 2 3 4 5
Ground Cover - Source: 0 1 2 3
Dominant species: ____________________
Dominant overstory species: ____________________

WATER IMPOUNDMENTS - PHYSICAL CHARACTERISTICS

Water impoundment no.: __________ Acres: __________
Depth: 0 1 2 3 Observed source of pollution: 0 1 2 3 4 5 6
Present utilization: 0 1 2 3 4

WATER IMPOUNDMENTS - VEGETATIONAL CHARACTERISTICS

Emergent vegetation: 0 1 Floating vegetation: 0 1
Submergent vegetation: 0 1 Dominant species: ____________________

MINE DRAINAGE (MD) - PHYSICAL CHARACTERISTICS

MD no.: __________
MD type of flow: 0 1 2 3 4 On-site source of MD: 0 1 2 3 4 5 6 7
MD's Per Source - Gob: 0 1 2 3 4 5 6 7 8 9

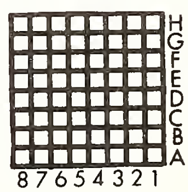
MINE DRAINAGE (MD) - PHYSICAL CHARACTERISTICS (continued)

MD's Per Source (continued)
Slurry: 0 1 2 3 4 5 6 7 8 9 Shaft: 0 1 2 3 4 5 6 7 8 9
Tipple: 0 1 2 3 4 5 6 7 8 9
General runoff: 0 1 2 3 4 5 6 7 8 9
Areas affected by MD: 0 1
On-site - Gob: 0 1 Slurry: 0 1 Tipple: 0 1
Impoundment: 0 1
Off-site - Adjacent ditch, stream, or river: 0 1
Adjacent impoundments: 0 1 Adjacent terrestrial areas: 0 1
Off-site affected terrestrial areas: __________ acres
Off-site affected aquatic areas: __________ acres

APPENDIX B

VARIABLE IDENTIFICATION AND CODE DEFINITIONS FOR FIELD SURVEY SHEETS AND OPTICAL SCANNER DATA FORMS

Variable No.	Label	Code Definition
001	Analysis type	1=Biographical, physical, vegetational information
002	County	See Appendix C
003	Mine classification (according to Illinois Department of Mines and Minerals)	0=Unclassified 1=Local 2=Shipping
004	Mine identification number	1-999=Mine identification number
005	Coal field division (Keystone 1974)	1=Northern 2=Western 3=West central 4=East central 5=Southwestern 6=Southern
006	Ownership of affected area	See Appendix D
007	Township number	0-99=Township number
008	Township location	1=North 2=South
009	Range number	0-99=Range number
010	Range location	1=East 2=West
011	Section number	0-36=Section number
012	Part of Section	0-8=Vertical grid coordinate, A-H 0-8=Horizontal grid coordinate, 1-8
013	Observable from aerial photo	0=None available 1=Yes 2=No



Variable No.	Label	Code Definition
014	CWRL aerial photo number	0-99
015	Environmental locale	1=Agricultural area 2=Urban residential 3=Urban industrial 4=Rural residential 5=Surface mine--active 6=Surface mine--inactive 7=Early invader species 8=Grasses and herbs 9=Herbs, shrubs, and small trees 10=Early forest 11=Mature forest 12=Lake 13=Highway 14=Golf course 15=Park
016	Potential problem area	0=No 1=Yes
017	Problem--exposed gob and/or slurry	0=No 1=Yes
018	Problem--tipple debris	0=No 1=Yes
019	Open and/or water-filled entrances	0=No 1=Yes
020	Mine drainage to adjacent areas	0=No 1=Yes
021	Mine operator	See Appendix E
022	Year mine opened	0-999=Last three digits of year
023	Year mine closed	0-999=Last three digits of year
024	Seam mined	0=Unknown 1-7=Seam number 9=Other (specify)
025	Seam thickness	0-99=Thickness in inches
026	Seam mined (if two seams were mined)	0=Unknown 1-7=Seam number 9=Other (specify)

Variable No.	Label	Code Definition
027	Seam thickness (second seam)	0-999=Thickness in inches
028	Depth from surface to seam (if second seam was mined)	0-999=Depth in feet
029	Type of opening	0=Unknown 1=Shaft 2=Slope 3=Drift 4=Both 1 & 2 5=Auger
030	Site surface mined after deep mining	0=Unknown 1=Yes 2=No
031	Tons of coal produced since mine was opened	See Appendix F
032	Status of mine site	1=Site no longer exists due to surface mining or other development 2=Site reverted to natural state with little or no evidence of past mining activity 3=Insufficient information to locate site 4=Site surveyed--abandoned 5=Site surveyed--all or part of abandoned underground mine is being utilized by an active mine to process or store coal 6=Active underground mine 7=Abandoned underground mines which were included in surface-mine survey (Haynes and Klimstra 1975a) 8=Access denied 9=Under construction
033	Date of survey	0-366=Julian date
034	Year of survey	5=1975 6=1976
035	Use of special preparation plant (Illinois Department of Mines and Minerals data)	0=No 1=Yes
121	Data sheet number	0-9=Sheet number

GOB - PHYSICAL CHARACTERISTICS

Variable No.	Label	Code Definition
036	Gob site number	0-9=Gob number
037	Active underground mining area	1=Yes 2=No
038	Evidence of burning	0=Unknown 1=Burned in past 2=Never burned 3=Currently burning
039	Amount burned	1=less than 10 percent 2=11 to 25 percent 3=26 to 50 percent 4=51 to 75 percent 5=76 to 100 percent
040	Height of gob pile	1=0 to 10 feet 2=11 to 20 feet 3=21 to 30 feet 4=31 to 40 feet 5=41 to 50 feet 6=51 to 60 feet 7=61 to 70 feet 8=71 to 80 feet 9=81 to 90+ feet
041	Volume of gob (cubic yards)	See Appendix F
042	Slope of gob pile	1=Nearly level, 0 to 2 percent slope 2=Sloping, 3 to 15 percent slope 3=Steep, 16 to 30 percent slope 4=Very steep, 31 to 45 percent slope 5=Extremely steep, greater than 45 percent slope
043	Erosion condition	1=No rills or gullies, assume sheet erosion 2=Rills less than 1 foot deep 3=Gullies more than 1 foot deep
044	Drainage from gob pile	0=No apparent 1=Adjacent waterway or terrestrial areas 2=Stagnant water on mine area 3=Both 1 and 2 4=Undetermined

Variable No.	Label	Code Definition
045	Composition of gob	0=Undetermined 1=Mostly rock 2=Mostly shale 3=Mostly clay 4=Mostly coal 5=Other (specify)
046	Fragment classification of gob	0=Undetermined 1=Fine, 1 inch in diameter and 1 inch thick 2=Intermediate, 1 to 6 inches in diameter, and 1 to 6 inches thick 3=Large, greater than 6 inches in diameter and 6 inches thick
047	Past treatment of gob area	0=None 1=Graded 2=Covered 3=Graded and covered 4=Removed 5=Experimental programs 6=Other (specify)
048	Present utilization of gob area	0=No apparent 1=Recreational 2=Landfill or refuse dump 3=Utilized by active mine to proces or store coal 4=Recovery operation for waste coal 5=Other (specify) 6=Active underground mine

GOB - VEGETATIONAL CHARACTERISTICS

Variable No.	Label	Code Definition
049	Successional stage of gob vegetation	0=None 1=Early invaders 2=Grasses and herbs 3=Herbs, shrubs and small trees 4=Early forest 5=Mature forest
050	Distribution of ground cover	0=None present 1=Lower slope or perimeter 2=Mid-slope 3=Upper slope 4=Scattered 5=Entire gob area
051	Density of ground cover vegetation (after Phillips 1959)	1=Barren to sparse or very sparse; covering 10 percent or less 2=May be numerous, but of small cover value; covering 11 to 25 percent 3=Covering 26 to 50 percent of ground surface 4=Covering 51 to 75 percent of ground surface 5=Covering more than 75 percent of ground surface
052	Source of ground cover vegetation	0=None present 1=Natural 2=Planted 3=Both 1 & 2
053	Dominant ground cover species	See Appendix G
054	Distribution of overstory vegetation	0=None present 1=Lower slope or perimeter 2=Mid-slope 3=Upper slope 4=Scattered 5=Entire gob area
055	Density of overstory vegetation	0=None present 1=Light, 10 percent or less 2=Moderate, 11 to 75 percent 3=Heavy, 76 to 100 percent

Variable No.	Label	Code Definition
056	Source of overstory vegetation	0=None present 1=Natural 2=Planted 3=Both 1 & 2
057	Successional stage of overstory vegetation	0=None present 1=Trees of all sizes 2=Mostly shrubs and saplings (less than 2.5 inches DBH) 3=Small diameter trees (2.5 to 6.0 inches DBH) 4=Medium and large trees (greater than 6.0 inches DBH)
058	Dominant overstory species	See Appendix G

SLURRY - PHYSICAL CHARACTERISTICS

Variable No.	Label	Code Definition
059	Slurry pond number	0-9=Slurry pond number
060	Active underground mine	1=Yes 2=No
061	Holding surface water	1=Yes 2=No
062	Erosion condition	1=No rills or gullies, assume sheet erosion 2=Rills less than 1 foot deep 3=Gullies more than 1 foot deep
063	Drainage from slurry	0=No apparent 1=Adjacent waterway or terrestrial areas 2=Stagnant water on mine areas 3=Both 1 and 2 4=Undetermined
064	Past treatment of slurry area	0=None 1=Covered with soil 2=Removed 3=Experimental programs 4=Other (specify)
065	Present utilization of slurry area	0=No apparent 1=Recreational 2=Landfill or refuse dump 3=Utilized by active mine to process coal 4=Recovery operation for waste coal 5=Other (specify) 6=Active underground mine

SLURRY - VEGETATIONAL CHARACTERISTICS

Variable No.	Label	Code Definition
066	Successional stage of slurry vegetation	0=None present 1=Early invaders 2=Grasses and herbs 3=Herbs, shrubs, and small trees 4=Early forest 5=Mature forest
067	Distribution of vegetation	0=None present 1=Perimeter 2=Center 3=Entire
068	Density of ground cover vegetation (after Phillips 1959)	0=None present 1=Barren to sparse or very sparse; covering 10 percent or less 2=May be numerous, but of small cover value; 11 to 25 percent 3=Covering 26 to 50 percent of ground surface 4=Covering 51 to 75 percent of ground surface 5=Covering more than 75 percent of ground surface
069	Source of ground cover vegetation	0=None present 1=Natural 2=Planted 3=Both 1 and 2
070	Dominant ground cover species	See Appendix G
071	Density of overstory vegetation	0=None present 1=Light, 10 percent or less 2=Moderate, 11 to 75 percent 3=Heavy, 76 to 100 percent
072	Source of overstory vegetation	0=None present 1=Natural 2=Planted 3=Both 1 and 2
073	Successional stage of vegetation	0=None present 1=Trees of all sizes 2=Mostly shrubs and saplings (less than 2.5 inches DBH)

Variable No.	Label	Code Definition
073	Successional stage of vegetation (continued)	3=Small diameter trees (2.5 to 6.0 inches DBH) 4=Medium and large trees (greater than 6.0 inches DBH)
074	Dominant overstory species	See Appendix G

TIPPLE - PHYSICAL CHARACTERISTICS

Variable No.	Label	Code Definition
075	Tipple site number	0-9=Tipple site number
076	Active underground mine	1=Yes 2=No
077	Number of buildings	0-9=Number
078	Number of entrances found	0-9=Number
079	Number of open and/or flooded entrances	0-9=Number
080	Number of sealed entrances (Illinois Department of Mines and Minerals data)	0-9=Number
081	Year sealed (Illinois Department of Mines and Minerals data)	0-999=Last three digits of year
082	Type of open and/or flooded entrance	0=None 1=Main shaft 2=Air and/or escape shaft 3=Both 1 and 2
083	Tipple debris	0=None present 1=Machinery 2=Buildings and foundations 3=Other (specify) 4=Both 1 and 2
084	Roads on tipple area	0-9.9=Miles (in tenths)
085	Type of road surface	1=Gob 2=Dirt 3=Rock and gravel 4=Paved 5=Other (specify)
086	Railroad on tipple area	0-9.9=Miles (in tenths)
087	Physical and vegetational characteristics of tipple	0=Distinct from gob area 999=Same as gob area

Variable No.	Label	Code Definition
088	Erosion condition	1=No rills or gullies, assume sheet erosion 2=Rills less than 1 foot deep 3=Gullies more than 1 foot deep
089	Drainage from tipple area	0=No apparent 1=Adjacent waterway or terrestrial area 2=Stagnant water on mine area 3=Both 1 and 2 4=Undetermined
090	Present utilization of tipple area	0=No apparent 1=Recreational 2=Landfill or refuse dump 3=Utilized by active mine to process or store coal 4=Recovery operation for waste coal 5=Other (specify) 6=Active underground mine

TIPPLE - VEGETATIONAL CHARACTERISTICS

Variable No.	Label	Code Definition
091	Successional stage of tipple vegetation	0=None present 1=Early invaders 2=Grasses and herbs 3=Herbs, shrubs, and small trees 4=Early forest 5=Mature forest 6=Evaluated with gob vegetation
092	Distribution of vegetation	0=None present 1=Scattered 2=Entire 3=Perimeter
093	Density of ground cover vegetation (after Phillips 1959)	1=Barren to sparse or very sparse; covering 10 percent or less 2=May be numerous, but of small cover value; covering 11 to 25 percent of ground surface 3=Covering 26 to 50 percent of ground surface 4=Covering 51 to 75 percent of ground surface 5=Covering more than 75 percent of ground surface
094	Source of ground cover vegetation	0=None present 1=Natural 2=Planted 3=Both 1 and 2
095	Dominant ground cover species	See Appendix G
096	Dominant overstory species	See Appendix G

WATER IMPOUNDMENTS - PHYSICAL CHARACTERISTICS

Variable No.	Label	Code Definition
097	Water impoundment number	0-9=Number of impoundment
098	Depth classification	1=less than 5 feet deep over 50 percent of area 2=Greater than 5 feet deep over 50 percent of area 3=Undetermined
099	Pollution source	0=None 1=Gob runoff 2=Slurry runoff 3=Tipple runoff 4=Dumping 5=General runoff from entire mine area 6=Undetermined 7=Other (specify)
100	Present utilization of impoundment	0=No apparent 1=Recreational 2=Dumping 3=Utilized by active mine to process coal 4=Recovery operation for waste coal 5=Other (specify) 6=Active underground mine

WATER IMPOUNDMENTS - VEGETATIONAL CHARACTERISTICS

Variable No.	Label	Code Definition
101	Emergent vegetation	0=None present 1=Present
102	Floating vegetation	0=None present 1=Present
103	Submergent vegetation	0=None present 1=Present
104	Dominant species	See Appendix G

MINE DRAINAGE - PHYSICAL CHARACTERISTICS

Variable No.	Label	Code Definition
105	Mine drainage number	0-9=Mine drainage number
106	Type of flow	0=No apparent 1=General runoff from mine area (intermittent) 2=Continuous drainage 3=Pools 4=Springs 5=Other (specify)
107	Source of mine drainage	0=No apparent 1=Gob only 2=Slurry only 3=Tipple only 4=Shafts 5=General runoff from entire mine area 6=Undetermined 7=Other (specify)
108	Number of drainages from gob	0-8=Number 9=General runoff
109	Number of drainages from slurry	0-8=Number 9=General runoff
110	Number of drainages from tipple	0-8=Number 9=General runoff
111	Number of drainages from shafts	0-8=Number 9=General runoff
112	Number of drainages from general mine area	0-8=Number 9=General runoff
113	Areas affected by mine drainage	0=No apparent 1=Areas are affected
114	Gob affected by mine drainage	0=No 1=Yes
115	Slurry affected by mine drainage	0=No 1=Yes
116	Tipple affected by mine drainage	0=No 1=Yes

Variable No.	Label	Code Definition
117	On-site impoundment(s) affected by mine drainage	0=No 1=Yes
118	Adjacent ditch or waterway affected by mine drainage	0=No 1=Yes
119	Off-site aquatic area(s) affect by mine drainage (e.g. lakes and farm ponds)	0=No 1=Yes
120	Off-site terrestrial area(s) affected by mine drainage	0=No 1=Yes

AFFECTED ACREAGE

Variable No.	Label	Code Definition
122	Total affected acreage (recorded on data sheet #1 only)	0-999.9=Acres in tenths
123	Gob acreage	0-999.9=Acres in tenths
124	Slurry acreage	0-999.9=Acres in tenths
125	Tipple acreage	0-999.9=Acres in tenths
126	On-site water impoundment acreage	0-999.9=Acres in tenths
127	Off-site affected terrestrial acreage	0-999.9=Acres in tenths
128	Off-site affected aquatic acreage	0-999.9=Acres in tenths

POTENTIAL REFUSE AND WATER SAMPLE COLLECTION

129	Potential gob sample	0=Not necessary 1=Collect sample
130	Potential slurry sample	0=Not necessary 1=Collect sample
131	Potential water sample	0=Not necessary 1=Collect sample

APPENDIX C

CODE IDENTIFICATIONS FOR ILLINOIS COUNTIES IN WHICH DEEP MINING FOR COAL WAS RECORDED

Code	County
1	Adams
3	Bond
5	Brown
6	Bureau
7	Calhoun
9	Cass
10	Champaign
11	Christian
12	Clark
14	Clinton
15	Coles
17	Crawford
18	Cumberland
21	Douglas
23	Edgar
24	Edwards
28	Franklin
29	Fulton
30	Gallatin
31	Greene
32	Grundy
34	Hancock
35	Hardin
37	Henry
39	Jackson
40	Jasper
41	Jefferson
42	Jersey
44	Johnson
46	Kankakee
48	Knox
50	La Salle
51	Lawrence
53	Livingston
54	Logan
55	Macon
56	Macoupin
57	Madison
58	Marion
59	Marshall
62	McDonough
64	McLean
65	Menard

Code	County
66	Mercer
68	Montgomery
69	Morgan
70	Moultrie
72	Peoria
73	Perry
75	Pike
76	Pope
78	Putnam
79	Randolph
80	Richland
81	Rock Island
82	Saline
83	Sangamon
84	Schuyler
85	Scott
86	Shelby
87	Stark
88	St. Clair
90	Tazewell
92	Vermilion
93	Wabash
94	Warren
95	Washington
97	White
99	Will
100	Williamson
102	Woodford

APPENDIX D

CODED LIST OF SURFACE OWNERS OF COAL SUB-SURFACE-MINED LANDS IN ILLINOIS ACCORDING TO MOST RECENT PLAT BOOKS AS OF 1975

Private Individual or Family Owners

Code	Owner
001	All private individual or family owners grouped into one category

Federal

002	U.S. Department of the Interior
003	U.S. Department of Agriculture
004	Unassigned
005	Camp Lincoln
006-010	Unassigned

State

011	State of Illinois
012-013	Unassigned
014	New Salem State Park
015-017	Unassigned
018	Illinois Highway Department
019	Department of Conservation
020	State of Illinois

City and County

021	City of Marion
022	City of Herrin
023	City of Galatia
024	City of Eldorado
025	City of Carrier Mills
026	City of O'Fallon
027	St. Clair County School District
028	City of Carlyle
029	Clinton County
030	Franklin County Highway Department
031-060	Unassigned
061	City of Virden
062	City of Bunker Hill
063	City of Carlinville
064	Madison County Park
065	Mt. Pulaski Township
066	City of Athens

City and County (continued)

067 Collinsville School District
068 Edwardsville Municipal Water
069 Maryville School District
070 Edwardsville Park District
071 Edwardsville School District
072 Assumption School District
073-100 Unassigned
101 Metropolitan Sanitation District of Greater Chicago
102 Canton Water Works District
103 City of Norris
104 Rock Island County Forest Preserve
105 Fon Du Lac Park District
106 Pekin Park District
107 Norwood Park District
108 City of Roanoke
109 City of Minonk
110 City of Colfax
111 City of Cherry
112 City of Ladd
113 City of Spring Valley
114 City of Danville
115 City of Wenona
116 City of Toluca
117 City of Sparland
118 City of Streator
119 City of Ottawa
120-150 Unassigned

Recreational Organizations and Residential Groups

151 Freeburg Recreation Project
152 Marissa Recreation Area Association
153 Belleville Enduro Team
154-180 Unassigned
181 Canton Park District
182 Wee-Ma-Tuk Hills, Inc.
183 Boy Scouts of America
184 Hiram Walker Rod and Gun Club
185 Golf Mohr Golf Course
186 Oakwood Country Club
187 Sherwood Youth Camp
188 Little John Conservation Club
189 Goose Lake Corporation
190 Coal City Area Club
191 Lincoln Lakes No. 2
192 Grundy County Rod and Gun Club
193 Area 1 Outdoor Club
194 Wilmington Community Swimming Pool

Recreational Organizations and Residential Groups (continued)

195 Lakeland Bluffs Inc.
196 Polywog Association
197 Shangraila Corporation
198 Trailway Girl Scouts
199-200 Unassigned

Mining Companies

201 Alden Coal Company
202 AMAX Coal Co.
203 Bankston Creek Collieries
204 Bell and Zoller Coal and Mining Co.
205 Big Creek Coal Co.
206 Big Four-Wilmington Coal Co.
207 Big Muddy Coal and Iron Co.
208 Black Diamond Coal Co.
209 Blue Bird Coal Co.
210 Breese-Trenton Mining Co.
211 Chicago and Big Muddy Coal Co.
212 Chicago-Milwaukee and St. Paul Coal Co.
213 Chicago-Springfield Coal Co.
214 Chicago-Wilmington and Franklin Coal Co.
215 Chicago-Wilmington and Vermilion Coal Co.
216 Citizens Coal Co.
217 Consolidated Coal Co./Consolidation Coal Co.
218 Consolidated Coal Co. of St. Louis
219 Cooperative Coal Co.
220 Cosgrave-Meehan Coal Co.
221 Crescent Coal Co.
222 Dering Coal Co.
223 Donk Brothers Coal Co.
224 Eureka Coal Mining Co.
225 Franklin County Coal Corp.
226 Freeman Coal Mining Corp.
227 Gartside Coal Co.
228 Harrisburg Coal Co.
229 Illinois Coal Corp.
230 Indiana and Illinois Coal Corp.
231 Inland Steel
232 Interstate Coal Co.
233 Kolb Coal Co.
234 Madison Coal Co.
235 Monterey Coal Co.
236 New Black Diamond Coal Co.
237 Panther Creek Mine Inc.
238 Peabody Coal Co.
239 Perry Coal Co.
240 O'Gara Coal Co.

Mining Companies (continued)

241 Old Ben Coal Co.
242 Sahara Coal Corp.
243 Saline County Coal Corp.
244 Southern Coal, Coke & Mining Co.
245 Southern Gem Coal Corp.
246 Square Deal Coal Corp.
247 St. Louis and O'Fallon Coal Co.
248 St. Louis Coal and Iron
249 Star Coal Co.
250 Superior Coal Co.
251 Truax-Traer Coal Co.
252 Union Fuel Co.
253 United States Coal and Coke
254 United States Fuel Co.
255 V-Day Coal Co.
256 Whip-Poor-Will Coal Co.
257 White Ash Coal Co.
258 Willis Coal & Mining Co.
259 Wilmington Coal and Manufacturing
260 Wilmington-Springfield Coal Co.
261 Zeigler Coal Co.
262 United Electric Coal Co.
263 Morgan Coal Co.
264 Delta Colliers
265 American Smelting and Refining
266 Midland Electric Coal Co.
267 Chicago & Harrisburg Coal Co.
268 Southwestern Illinois Coal Co.
269 Hydraulic Press Brick
270-274 Unassigned
275 Coal Valley Mining Co.
276 St. Paul Coal Co.
277 Illinois Third Vein Coal Co.
278 Spring Valley Coal Co.
279 Marquette Third Vein Coal Co.
280 Wilmington Star Mining Co.
281 Wenona Coal Co.
282 Toluca Coal Co.
283 Illinois Valley Coal Co.
284 Braceville Coal Co.
285 Rutland Coal Co.
286 Cedar Point Coal Co.
287 La Salle County Carbon Coal Co.
288 Union Coal Co.
289 Peru Deep Vein Coal Co.
290-350 Unassigned

Utility Companies

351 Central Illinois Public Service Co.
352-380 Unassigned
381 Nuclear Resources
382 Central Illinois Public Service Co.
383-385 Unassigned
386 Central Illinois Light Company
387 Commonwealth Edison
388 Illinois Power Co.
389 Northern Illinois Water Co.
390-400 Unassigned

Farm Corporations

401 Meadowlark Farms Inc.
402 Meadowbrook Farms Inc.
403 R. & R. Farms Inc.
404 Gateway Farms Inc.
405 Gypsy Hill Farms Inc.
406 Arklano Farms Inc.
407-460 Unassigned
461 Linn Farms Inc.
462 Linertz Farms Inc.
463 Stewart Hybrids Inc.
464 R. A. Grant Land & Cattle Co.
465-500 Unassigned

Bank and Trust Companies

501 Bank of Egypt
502 La Salle National Bank and Trust Co.
503 Belleville National Bank
504 Central and South Trust Company
505-530 Unassigned
531 First National Bank of Springfield
532 Belleville National Bank
533-560 Unassigned
561 Central Illinois National Bank and Trust Co.
562 First Galesburg Bank
563 First National Bank of Peoria
564 First National Bank of Moline
565 La Salle National Bank and Trust
566 Jamica Savings Bank
567-600 Unassigned

Universities, Colleges, Technical Schools, and Societies

601 Trico School
602-660 Unassigned
661 Chicago Zoological Society

Universities, Colleges, Technical Schools, and Societies

662 Blackburn College
663 Ryburn Hospital
664-700 Unassigned

Miscellaneous Companies

701 Kansas City Life Insurance Company
702 C. B. & O. Railroad
703 Management Service Corporation
704 Tri-No Enterprises Incorporated
705 Container Stapling Corp.
706 DuQuoin Packing Co.
707 Illinois Central Railroad
708 Clinton Hill Land Company
709 U.S. Steel Corporation
710 Centralia Engineering Corporation
711 C. E. Williamson Mining Co.
712-730 Unassigned
731 Gulf Oil Co.
732-759 Unassigned
760 United Shale Inc.
761 Farm Supply Inc.
762 The Scripps Company
763 Colchester Stone Co.
764 Alpha Enterprises Inc.
765 Viola Materials Inc.
766 American Central Corp.
767 United Shale Inc.
768 U.S. Steel Co.
769 Central Foundry
770 Northwestern Corp.
771 Central Valley Industrial Co.
772 A. L. Mechling Barge Lines Inc.
773 Ottawa Silica
774 Borden Chemical Co.
775 Streator Brick
776 Ristocrat Clay Production Company
777 Brown Oil Co.
778 Marquette Cement Co.
779 Clow Inc.
780-800 Unassigned

Other

801 Churches
802-874 Unassigned
875 Illinois Central Gulf Railroad
876 Chicago and Northwestern Railroad

Other (continued)

877 Illinois Terminal Railroad
878-887 Unassigned
888 Prairie Farms Dairy
889-920 Unassigned
921 American Legion
922 Keystone Steel and Wire Corp.
923 Pennsylvania Central Railroad

APPENDIX E

CODED LIST OF MINE OPERATORS OF UNDERGROUND COAL MINES IN ILLINOIS AS OF 1 SEPTEMBER 1976

Code Operator

Ownership Unknown

000 Unknown

Private Individuals, Partnerships, or Small Companies

001 Private Individuals etc.

Miscellaneous Companies

002-009 Unassigned
010 Chicago Retort Fire Brick Co.
011 Cooperative Tile Works
012 Crystal Plate Glass Co.
013 Gulf, Mobile, and Ohio Railroad
014 Hydraulic Press Brick Co.
015 Illinois Clay Products Co.
016 Illinois Zinc Company
117 Lowell Pottery Co.
018 McCraney Sand and Gravel Co.
019 National Fire Proofing Co.
020 Rock Island Improvement Co.
021 Standard Oil Co.
022 Streator Clay Manufacturing Co.
023 White Hall Fire Clay Co.
024 Western United Gas Coal Co.
025 Aluminum Orr Co.

Major Mining Companies

201 Alden Coal Co.
202 AMAX Coal Co.
203 Bankston Creek Coal Co.
204 Bell and Zoller Coal Co.
205 Big Creek Coal Co.
206 Big Four-Wilmington Coal Co.
207 Big Muddy Coal and Iron Co.
208 Black Diamond Coal Co.
209 Blue Bird Coal Co.
210 Breese-Trenton Mining Co.
211 Chicago and Big Muddy Coal Company

Major Mining Companies (continued)

212 Chicago-Milwaukee and St. Paul Coal Co.
213 Chicago-Springfield Coal Co.
214 Chicago-Wilmington and Franklin Coal Co.
215 Chicago-Wilmington and Vermilion Coal Co.
216 Citizens Coal Co.
217 Consolidation Coal Co.
218 Consolidated of St. Louis
219 Cooperative Coal Co.
220 Cosgrave-Meehan Coal Co.
221 Crescent Coal Co.
222 Dering Coal Co.
223 Donk Brothers Coal Co.
224 Eureka Coal Mining Co.
225 Franklin County Coal Co.
226 Freeman Coal Mining Co.
227 Gartside Coal Co.
228 Harrisburg Coal Co.
229 Illinois Coal Co.
230 Indiana and Illinois Coal Co.
231 Inland Steel Corp.
232 Interstate Coal Co.
233 Kolb Coal Co.
234 Madison Coal Co.
235 Monterey Coal Co.
236 New Black Diamond Coal Co.
237 Panther Creek Mine Inc.
238 Peabody Coal Co.
239 Perry Coal Co.
240 O'Gara Coal Co.
241 Old Ben Coal Co.
242 Sahara Coal Co.
243 Saline County Coal Co.
244 Southern Coal, Coke and Mining Co.
245 Southern Gem Coal Corp.
246 Square Deal Coal Co.
247 St. Louis and O'Fallon Coal Corp.
248 St. Louis Coal and Iron
249 Star Coal Co.
250 Superior Coal Co.
251 Truax-Traer Coal Co.
252 Union Fuel Co.
253 United States Coal and Coke Co.
254 United States Fuel Co.
255 V-Day Coal Co.
256 Whip-Poor-Will Coal Co.
257 White Ash Coal Co.
258 Willis Coal and Mining Co.
259 Wilmington Coal and Manufacturing

Major Mining Companies (continued)

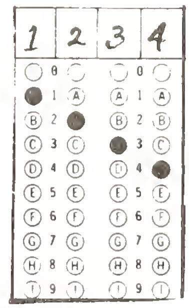
260 Wilmington-Springfield Coal Co.
261 Zeigler Coal Co.
262 United Electric Coal Co.
263 Morgan Coal Mine Co.
264 Delta Collieries
265 American Smelting and Refining Co.
266 Midland Electric Coal Co.
267 Chicago and Harrisburg Coal Co.
268 Southwestern Illinois Coal Co.
269 Hydraulic Press Brick Co.
270-274 Unassigned
275 Coal Valley Mining Co.
276 St. Paul Coal Co.
277 Illinois Third Vein Coal Co.
278 Spring Valley Coal Co.
279 Marquette Third Vein Coal Co.
280 Wilmington Star Mining Co.
281 Wenona Coal Co.
282 Toluca Coal Co.
283 Illinois Valley Coal Co.
284 Braceville Coal Co.
285 Rutland Coal Co.
286 Cedar Point Coal Co.
287 La Salle County Carbon Coal Co.
288 Union Coal Co.
289 Peru Deep Vein Coal Co.

APPENDIX F

CODING PROCEDURE FOR TONS OF COAL PRODUCED (VAR031) AND VOLUME OF GOB PILE (VAR041)

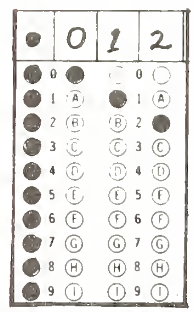
For entries between 1 and 9,999: For example:

Enter the appropriate digits in the four digit field.

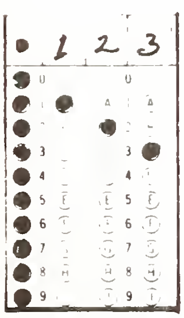


For entries greater than 9,999: For example:

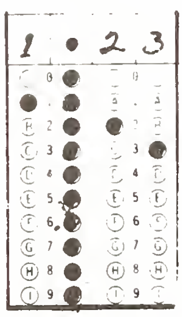
Coding involves a three digit entry and a decimal point to indicate a value expressed in millions. The decimal point is indicated by coding 0 through 9 in the appropriate column.



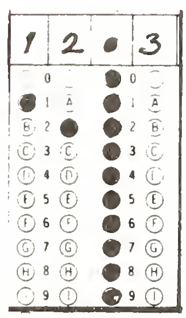
$X10^6$=12,000



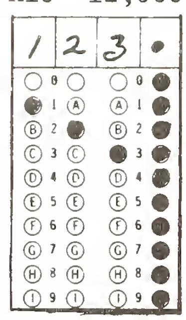
$X10^6$=123,000



$X10^6$=1,230,000



$X10^6$=12,300,000



$X10^6$=123,000,000

APPENDIX G

CODE IDENTIFICATIONS FOR TERRESTRIAL AND AQUATIC VEGETATION

Terrestrial Vegetation Codes

Code	Species
Trees	
01	*Juniperus virginiana*
02	*Pinus* spp.
03	*Acer saccharinum*
04	*Acer rubrum*
05	*Acer negundo*
06	*Crataegus* spp.
07	*Prunus serotina*
08	*Gleditsia triacanthos*
09	*Robinia pseudoacacia*
10	*Quercus alba*
11	*Platanus occidentalis*
12	*Quercus imbricaria*
13	*Quercus marilandica*
14	*Quercus falcata*
15	*Quercus rubra*
16	*Quercus palustris*
17	*Quercus velutina*
18	*Quercus stellata*
19	*Betula nigra*
20	*Ostrya virginiana*
21	*Carya ovata*
22	*Populus deltoides*
23	*Salix nigra*
24	*Ulmus americana*
25	*Ulmus alata*
26	*Ulmus rubra*
27	*Morus rubra*
28	*Sassafras albidum*
29	*Cornus florida*
30	*Fraxinus americana*
31	*Diospyros virginiana*
Shrubs	
32	*Rhus copallina*
33	*Rhus glabra*
34	*Rhus radicans*
35	*Vitis* spp.
36	*Parthenocissus quinquefolia*
37	*Rubus flagellaris*
38	*Rubus* spp.
39	*Rosa* spp.
40	*Campsis radicans*
41	*Cephalanthus occidentalis*
42	*Lonicera japonica*
43	*Smilax* spp.
Grasses	
44	Gramineae
45	*Bromus tectorum*
46	*Bromus* spp.
47	*Festuca* spp.
48	*Elymus* spp.
49	*Hordeum pusillum*
50	*Agrostis* spp.
51	*Muhlenbergia* spp.
52	*Aristida* spp.
53	*Paspalum* spp.
54	*Panicum* spp.
55	*Echinochloa* spp.
56	*Digitaria sanguinalis*
57	*Setaria* spp.
58	*Andropogon virginicus*
97	*Phragmites australis*
98	*Poa* spp.
Sedges	
59	*Juncus tenuis*
60	*Juncus* spp.
61	*Cyperus* spp.
62	*Eleocharis* spp.
63	*Carex* spp.
Forbs	
64	*Brassica* spp.
65	*Lepidium* spp.
66	*Chenopodium* spp.
67	*Amaranthus* spp.
68	*Phytolacca americana*

Terrestrial Vegetation Codes (Continued)

Code	Species
Forbs (continued)	
69	*Rumex* spp.
70	*Hydrangea arborescens*
71	*Fragaria virginiana*
72	*Potentilla simplex*
73	*Melilotus* spp.
74	*Lespedeza* spp.
75	*Oenothera* spp.
76	*Daucus carota*
77	*Asclepias syriaca*
78	*Ipomoea pandurata*
79	*Plantago* spp.
80	*Verbena* spp.
81	*Sambucus canadensis*
82	*Ambrosia artemisiifolia*
83	*Ambrosia bidentata*
84	*Xanthium* spp.
85	*Eupatorium* spp.
86	*Solidago* spp.
87	*Aster* spp.
88	*Erigeron* spp.
89	*Erigeron canadensis*
90	*Rudbeckia hirta*
91	*Helianthus* spp.
92	*Achillea millefolium*
93	*Arctium* spp.
94	*Cirsium* spp.
95	*Cichorium intybus*
96	*Lactuca* spp.
99	Other (specify)

Aquatic Vegetation Codes

Code	Species
01	*Lemna* spp.
02	*Spirodela minor*
03	*Wolffia* spp.
04	*Azolla mexicana*
05	*Chara* spp.
06	*Nitella* spp.
07	*Ceratophyllum demersum*
08	*Callitriche* spp.
09	*Bacopa rotundifolia*
10	*Utricularia* spp.
11	*Naias minor*
12	*Potamogeton* spp.
13	*Elodea* spp.
14	*Ranunculus* spp.
15	*Myriophyllum* spp.
16	*Prosperinaca palustris*
17	*Marsilea quadrifolia*
18	*Nuphar advena*
19	*Nelumbo lutea*
20	*Jussiaea repens*
21	*Ludwigia palustris*
22	*Typha latifolia*
23	*Justicia americana*
24	*Sagittaria* spp.
25	*Alisma subchordatum*
26	*Echinodorus* spp.
27	*Pontederia cordata*
28	*Peltandra virginica*
29	*Cephalanthus occidentalis*
30	*Brasenia schreberi*
31	*Nymphaea tuberosa*
32	*Polygonum* spp.
33	*Penthorum* sedoides
34	*Isoetes* spp.
35	*Equisetum* spp.
36	*Armoracia rusticana*
37	*Sparganium* spp.
38	*Eleocharis* spp.
39	*Cyperus* spp.
40	*Carex* spp.
41	*Scirpus* spp.
42	*Juncus* spp.
43	*Phragmites australis*
44	*Salix* spp.

APPENDIX H

FORMAT SPECIFICATIONS FOR BIOGRAPHIC, VEGETATIONAL, AND PHYSICAL VARIABLES USED IN SURVEY OF UNDERGROUND COAL MINES IN ILLINOIS

Variable	Format	Columns	Variable	Format	Columns
VAR001	F1.0	1-1	VAR041	F9.0	84-92
VAR002	F3.0	2-4	VAR042	F1.0	93-93
VAR003	F1.0	5-5	VAR043	F1.0	94-94
VAR004	F3.0	6-8	VAR044	F1.0	95-95
VAR005	F1.0	11-11	VAR045	F1.0	96-96
VAR006	F3.0	12-14	VAR046	F1.0	97-97
VAR007	F2.0	15-16	VAR047	F1.0	98-98
VAR008	F1.0	17-17	VAR048	F1.0	99-99
VAR009	F2.0	18-19	VAR049	F1.0	100-100
VAR010	F1.0	20-20	VAR050	F1.0	101-101
VAR011	F2.0	21-22	VAR051	F1.0	102-102
VAR012	F2.0	23-24	VAR052	F1.0	103-103
VAR013	F1.0	25-25	VAR053	F2.0	104-105
VAR014	F2.0	26-27	VAR054	F1.0	106-106
VAR015	F2.0	28-29	VAR055	F1.0	107-107
VAR016	F1.0	30-30	VAR056	F1.0	108-108
VAR017	F1.0	31-31	VAR057	F1.0	109-109
VAR018	F1.0	32-32	VAR058	F2.0	110-111
VAR019	F1.0	33-33	VAR059	F1.0	112-112
VAR020	F1.0	34-34	VAR060	F1.0	113-113
VAR021	F3.0	35-37	VAR061	F1.0	114-114
VAR022	F3.0	38-40	VAR062	F1.0	118-118
VAR023	F3.0	41-43	VAR063	F1.0	119-119
VAR024	F1.0	44-44	VAR064	F1.0	120-120
VAR025	F3.0	47-49	VAR065	F1.0	121-121
VAR026	F1.0	50-50	VAR066	F1.0	122-122
VAR027	F3.0	51-53	VAR067	F1.0	123-123
VAR028	F3.0	54-56	VAR068	F1.0	124-124
VAR029	F1.0	57-57	VAR069	F1.0	125-125
VAR030	F1.0	58-58	VAR070	F2.0	126-127
VAR031	F9.0	59-67	VAR071	F1.0	128-128
VAR032	F1.0	68-68	VAR072	F1.0	129-129
VAR033	F3.0	69-71	VAR073	F1.0	130-130
VAR034	F1.0	72-72	VAR074	F2.0	131-132
VAR035	F1.0	73-73	VAR075	F1.0	133-133
VAR036	F1.0	76-76	VAR076	F1.0	134-134
VAR037	F1.0	77-77	VAR077	F1.0	135-135
VAR038	F1.0	78-78	VAR078	F1.0	136-136
VAR039	F1.0	79-79	VAR079	F1.0	137-137
VAR040	F1.0	83-83	VAR080	F1.0	138-138

Variable	Format	Columns	Variable	Format	Columns
VAR081	F3.0	139-141	VAR127	F4.1	217-220
VAR082	F1.0	142-142	VAR128	F4.1	221-224
VAR083	F1.0	143-143	VAR129	F1.0	241-241
VAR084	F2.1	144-145	VAR130	F1.0	242-242
VAR085	F1.0	146-146	VAR131	F1.0	243-243
VAR086	F2.1	147-148			
VAR087	F3.0	149-151			
VAR088	F1.0	152-152			
VAR089	F1.0	153-153			
VAR090	F1.0	154-154			
VAR091	F1.0	155-155			
VAR092	F1.0	156-156			
VAR093	F1.0	157-157			
VAR094	F1.0	158-158			
VAR095	F2.0	159-160			
VAR096	F2.0	161-162			
VAR097	F1.0	163-163			
VAR098	F1.0	167-167			
VAR099	F1.0	168-168			
VAR100	F1.0	169-169			
VAR101	F1.0	170-170			
VAR102	F1.0	171-171			
VAR103	F1.0	172-172			
VAR104	F2.0	173-174			
VAR105	F1.0	175-175			
VAR106	F1.0	176-176			
VAR107	F1.0	177-177			
VAR108	F1.0	178-178			
VAR109	F1.0	179-179			
VAR110	F1.0	180-180			
VAR111	F1.0	181-181			
VAR112	F1.0	182-182			
VAR113	F1.0	183-183			
VAR114	F1.0	184-184			
VAR115	F1.0	185-185			
VAR116	F1.0	186-186			
VAR117	F1.0	187-187			
VAR118	F1.0	188-188			
VAR119	F1.0	189-189			
VAR120	F1.0	190-190			
VAR121	F2.0	195-196			
VAR122	F4.1	197-200			
VAR123	F4.1	201-204			
VAR124	F4.1	205-208			
VAR125	F4.1	209-212			
VAR126	F4.1	213-216			

APPENDIX I

LOCATION AND EVALUATION OF PROBLEM CONDITIONS ASSOCIATED WITH ABANDONED UNDERGROUND MINE SITES IN ILLINOIS COUNTIES AS OF 1 SEPTEMBER 1976.

County and Location[a]	Mine Index Number[b]	Problem Index Points[c]	Problem Acreage: Total	Gob	Slurry	Tipple	On-site Impound-ment	Off-site Terres-trial	Off-site Aquatic	Gob Volume (Cu. yards)	Problem Openings[d]	Potential Off-site Drainage[e]
BOND												
T4N-R4W-S3 (C6)	S001	11	1.8	0.4	0.0	1.4	0.0	0.0	0.0	600	0	no
T5N-R2W-S8 (F4)	U001	19	0.3	0.3	0.0	0.0	0.0	0.0	0.0	1,900	0	no
Total			2.1	0.7	0.0	1.4	0.0	0.0	0.0	2,500	0	
BUREAU												
T16N-R11E-S10 (E7)	U002	336	54.4	30.3	0.0	11.8	0.0	12.3	0.0	3,704,000	0	yes
T16N-R11E-S18 (A5)	U003	253	26.2	15.0	0.0	0.0	0.0	9.0	2.2	1,935,000	0	yes
T16N-R11E-S24 (D6)	U004	358	34.3	26.0	0.0	0.3	0.0	8.0	0.0	2,782,000	0	yes
T16N-R11E-S31 (B3)	U005	126	9.9	7.9	0.0	0.0	0.0	2.0	0.0	651,000	0	yes
T16N-R11E-S33 (E5)	S001	206	21.2	18.8	0.0	0.0	0.1	2.3	0.0	945,000	0	yes
T16N-R11E-S35 (A7)	U006	187	21.1	14.4	0.0	0.0	1.7	5.0	0.0	2,090,000	0	yes
T16N-R11E-S35 (F4)	U007	132	11.4	11.4	0.0	0.0	0.0	0.0	0.0	1,200,000	0	yes
T17N-R11E-S27 (E7)	U001	227	24.2	18.8	0.0	1.0	0.0	4.4	0.0	3,340,000	0	no
Total			202.7	142.6	0.0	13.1	1.8	43.0	2.2	16,647,000	0	
CHRISTIAN												
T11N-R1E-S15 (E5)	U002	48	2.5	1.1	0.0	0.0	0.0	1.4	0.0	26,000	0	no
T11N-R1E-S16 (A2)	S001	19	5.5	5.5	0.0	0.0	0.0	0.0	0.0	8,800	0	no
T11N-R1E-S28 (C5)	S007	59	11.9	11.9	0.0	0.0	0.0	0.0	0.0	50,000	0	no
T12N-R1E-S2 (D3)	U003	42	7.2	7.2	0.0	0.0	0.0	0.0	0.0	60,000	0	no
T13N-R2W-S19 (F4)	S004	22	6.9	6.9	0.0	0.0	0.0	0.0	0.0	11,000	0	no
T13N-R2W-S33 (E3)	S005	32	1.7	1.7	0.0	0.0	0.0	0.0	0.0	11,000	0	no
T13N-R3W-S14 (G8)	S002	42	0.2	0.0	0.0	0.2	0.0	0.0	0.0	0	0	yes
Total			35.9	34.3	0.0	0.2	0.0	1.4	0.0	166,800	0	
CLINTON												
T2N-R3W-S22 (G8)	S001	20	2.3	2.3	0.0	0.0	0.0	0.0	0.0	3,700	0	yes

County and Location	Mine Index Number	Problem Index Points	Problem Acreage: Total	Gob	Slurry	Tipple	On-site Impound-ment	Off-site Terres-trial	Off-site Aquatic	Gob Volume (Cu. yards)	Problem Openings	Potential Off-site Drainage
CRAWFORD												
T6N-R11W-S27 (C4)	U002	17	0.9	0.2	0.0	0.0	0.0	0.7	0.0	400	0	no
EDGAR												
T14N-R10W-S9 (C6)	U013	74	12.2	3.5	0.0	1.7	0.0	7.0	0.0	114,000	1	no
T14N-R10W-S20 (D3)	U001	19	2.2	2.2	0.0	0.0	0.0	0.0	0.0	3,500	0	no
Total			14.4	5.7	0.0	1.7	0.0	7.0	0.0	117,500	1	
FRANKLIN												
T5S-R2E-S19 (F4)	U001	31	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	1	no
T6S-R1E-S1 (D1)	S014	264	151.5	37.9	29.9	44.8	0.0	37.9	1.0	305,000	0	yes
T6S-R2E-S4 (E3)	U003	29	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	1	no
T6S-R3E-S21 (H1)	U007	85	40.9	13.0	0.0	0.0	0.0	27.9	0.0	63,000	0	no
T6S-R3E-S34 (H5)	S024	121	84.8	15.0	35.9	0.0	0.0	33.9	0.0	121,000	2	no
T6S-R3E-S35 (B1)	U009	34	5.0	5.0	0.0	0.0	0.0	0.0	0.0	2,000	0	yes
T7S-R1E-S26 (E6)	U002	197	206.2	61.8	99.6	16.9	0.0	27.9	0.0	17,000	0	no
T7S-R1E-S28 (E8)	S007	48	60.7	30.9	10.0	12.0	0.0	7.8	0.0	2,500	0	no
T7S-R2E-S13 (B5)	S004	240	170.4	97.7	17.9	0.0	12.0	42.8	0.0	506,000	0	yes
T7S-R3E-S8 (A1)	S012	121	55.8	23.9	21.9	0.0	0.0	10.0	0.0	116,000	0	yes
T7S-R3E-S18 (B6)	U011	36	4.0	3.0	0.0	0.0	0.0	1.0	0.0	9,700	0	no
T7S-R3E-S20 (C2)	S020	267	158.2	48.8	29.7	18.9	0.0	60.8	0.0	787,000	0	yes
Total			937.5	337.0	244.9	92.6	12.0	250.0	1.0	1,929,200	4	

County and Location	Mine Index Number	Problem Index Points	Problem Acreage: Total	Gob	Slurry	Tipple	On-site Impound-ment	Off-site Terres-trial	Off-site Aquatic	Gob Volume (Cu. yards)	Problem Openings	Potential Off-site Drainage
FULTON												
T3N-R1E-S23 (C6)	L186	23	0.5	0.5	0.0	0.0	0.0	0.0	0.0	4,000	0	no
T5N-R3E-S15 (A1)	U244	16	0.3	0.3	0.0	0.0	0.0	0.0	0.0	1,600	0	no
T5N-R3E-S18 (D5)	U254	18	0.2	0.2	0.0	0.0	0.0	0.0	0.0	1,600	0	no
T5N-R3E-S23 (C1)	U250	21	0.3	0.3	0.0	0.0	0.0	0.0	0.0	2,400	0	no
T5N-R4E-S12 (G3)	U074	27	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0	1	no
T5N-R4E-S13 (H4)	L026	41	0.3	0.2	0.0	0.0	0.0	0.1	0.0	200	0	yes
T5N-R5E-S7 (A8)	U077	20	0.6	0.5	0.0	0.0	0.0	0.1	0.0	5,800	0	no
T5N-R5E-S7 (B8)	U076	15	0.5	0.4	0.0	0.0	0.0	0.1	0.0	1,000	0	no
T5N-R5E-S7 (E4)	L198	18	0.7	0.2	0.0	0.5	0.0	0.0	0.0	600	0	yes
T5N-R5E-S7 (G1)	U073	39	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0	1	no
T6N-R3E-S7 (G1)	L192	27	3.4	2.5	0.0	0.6	0.0	0.3	0.0	8,100	0	no
T6N-R3E-S8 (B7)	U032	55	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0	1	yes
T6N-R3E-S8 (B7)	U033	17	0.1	0.1	0.0	0.0	0.0	0.0	0.0	300	0	yes
T6N-R3E-S8 (D7)	U065	18	0.3	0.3	0.0	0.0	0.0	0.0	0.0	1,000	0	no
T6N-R3E-S16 (A4)	L101	18	2.2	1.6	0.0	0.1	0.0	0.3	0.2	7,700	0	no
T6N-R3E-S17 (F7)	U035	17	0.3	0.1	0.0	0.2	0.0	0.0	0.0	300	0	yes
T6N-R3E-S19 (G3)	U037	21	1.2	1.2	0.0	0.0	0.0	0.0	0.0	1,900	0	no
T6N-R3E-S25 (D1)	L116	17	0.3	0.3	0.0	0.0	0.0	0.0	0.0	200	0	yes
T6N-R3E-S29 (H6)	U041	19	0.5	0.5	0.0	0.0	0.0	0.0	0.0	800	0	no
T6N-R4E-S16 (F5)	U107	9	0.1	0.1	0.0	0.0	0.0	0.0	0.0	300	0	yes
T6N-R4E-S31 (H2)	U112	21	0.1	0.1	0.0	0.0	0.0	0.0	0.0	300	0	yes
T6N-R5E-S29 (A1)	U071	25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	1	no
T7N-R1E-S14 (E6)	U184	21	0.4	0.4	0.0	0.0	0.0	0.0	0.0	1,300	0	yes
T7N-R1E-S14 (F5)	U188	27	0.5	0.5	0.0	0.0	0.0	0.0	0.0	6,500	0	yes
T7N-R1E-S14 (G6)	U189	18	0.2	0.2	0.0	0.0	0.0	0.0	0.0	300	0	no
T7N-R2E-S27 (D1)	L099	27	1.9	1.9	0.0	0.0	0.0	0.0	0.0	6,100	0	yes
T7N-R4E-S3 (C1)	S010	29	3.4	1.4	0.0	2.0	0.0	0.0	0.0	34,000	0	no
T7N-R4E-S27 (D5)	U171	10	0.3	0.3	0.0	0.0	0.0	0.0	0.0	1,000	0	yes
T7N-R5E-S13 (G3)	L086	27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	1	no
T7N-R5E-S24 (G5)	L057	14	0.1	0.1	0.0	0.0	0.0	0.0	0.0	100	0	yes
T7N-R5E-S30 (D5)	L184	48	0.7	0.2	0.0	0.5	0.0	0.0	0.0	1,300	0	yes
T8N-R1E-S10 (E6)	L028	25	0.5	0.5	0.0	0.0	0.0	0.0	0.0	4,800	0	yes
T8N-R2E-S15 (E7)	U199	21	0.5	0.5	0.0	0.0	0.0	0.0	0.0	1,600	0	yes
T8N-R2E-S28 (C3)	U207	24	1.0	1.0	0.0	0.0	0.0	0.0	0.0	9,700	0	no
T8N-R2E-S28 (D5)	U197	22	0.8	0.3	0.0	0.5	0.0	0.0	0.0	2,400	0	no
T8N-R2E-S32 (D3)	U195	18	0.5	0.5	0.0	0.0	0.0	0.0	0.0	1,600	0	no
T8N-R4E-S1 (E3)	U096	18	0.1	0.1	0.0	0.0	0.0	0.0	0.0	100	0	yes
T8N-R4E-S3 (C2)	U093	37	1.0	0.7	0.0	0.0	0.0	0.3	0.0	29,000	0	yes
T8N-R4E-S15 (D5)	U091	22	1.7	1.7	0.0	0.0	0.0	0.0	0.0	5,500	0	no
T8N-R4E-S27 (C8)	U151	79	7.4	4.0	0.0	3.4	0.0	0.0	0.0	226,000	1	no
Total			33.2	23.7	0.0	8.0	0.0	1.3	0.2	369,400	6	

County and Location	Mine Index Number	Problem Index Points	Problem Acreage: Total	Gob	Slurry	Tipple	On-site Impound-ment	Off-site Terres-trial	Off-site Aquatic	Gob Volume (Cu. yards)	Problem Openings	Potential Off-site Drainage
GALLATIN												
T9S-R8E-S13 (B2)	L002	33	7.2	4.5	0.0	2.4	0.0	0.3	0.0	3,600	0	yes
T9S-R8E-S16 (F8)	L004	26	1.6	1.6	0.0	0.0	0.0	0.0	0.0	2,600	0	yes
T10S-R8E-S15 (E7)	L010	28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	1	no
T10S-R8E-S16 (H2)	U080	43	1.2	0.0	0.0	0.0	0.0	1.2	0.0	0	1	yes
T10S-R8E-S23 (H2)	L089	40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	1	yes
T10S-R9E-S19 (G5)	L003	17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	1	no
T10S-R9E-S27 (H8)	U075	21	0.9	0.8	0.0	0.0	0.0	0.1	0.0	600	0	yes
T10S-R9E-S30 (A4)	L017	33	1.0	0.9	0.0	0.1	0.0	0.0	0.0	300	1	yes
T10S-R9E-S30 (B5)	L014	27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	1	no
Total			11.9	7.8	0.0	2.5	0.0	1.6	0.0	7,100	6	
GREENE												
T12N-R11W-S23 (E7)	L045	16	0.2	0.2	0.0	0.0	0.0	0.0	0.0	100	0	yes
GRUNDY												
T31N-R8E-S10 (D2)	U113	33	1.8	1.8	0.0	0.0	0.0	0.0	0.0	23,000	0	yes
T31N-R8E-S11 (C4)	U114	59	5.3	5.3	0.0	0.0	0.0	0.0	0.0	86,000	0	yes
T31N-R8E-S14 (D5)	U115	87	4.4	9.1	0.0	0.0	0.0	0.0	0.0	209,000	0	yes
T31N-R8E-S23 (D3)	L003	100	12.6	11.8	0.8	0.0	0.0	0.0	0.0	286,000	0	yes
T31N-R8E-S25 (H3)	L007	23	0.4	0.4	0.0	0.0	0.0	0.0	0.0	3,200	0	yes
T32N-R6E-S23 (A2)	U109	44	5.2	4.5	0.0	0.7	0.0	0.0	0.0	44,000	0	yes
T32N-R8E-S2 (G5)	U085	35	2.3	2.3	0.0	0.0	0.0	0.0	0.0	7,400	1	yes
T32N-R8E-S3 (D3)	U087	37	9.1	5.1	4.0	0.0	0.0	0.0	0.0	4,100	0	yes
T32N-R8E-S5 (G2)	U089	46	8.6	8.6	0.0	0.0	0.0	0.0	0.0	55,000	0	yes
T32N-R8E-S11 (H8)	U090	32	0.8	0.8	0.0	0.0	0.0	0.0	0.0	6,500	0	yes
T32N-R8E-S12 (B2)	U095	26	4.6	3.2	0.0	0.0	1.4	0.0	0.0	3,500	0	yes
T32N-R8E-S13 (F2)	U096	35	2.2	2.2	0.0	0.0	0.0	0.0	0.0	28,000	0	yes
T32N-R8E-S13 (G7)	U097	54	6.5	6.5	0.0	0.0	0.0	0.0	0.0	84,000	0	yes
T32N-R8E-S14 (D3)	U098	67	4.9	4.9	0.0	0.0	0.0	0.0	0.0	79,000	1	yes
T32N-R8E-S23 (D3)	U100	69	3.9	3.3	0.0	0.0	0.6	0.0	0.0	106,000	1	yes
T32N-R8E-S23 (F6)	U099	117	54.8	22.9	31.9	0.0	0.0	0.0	0.0	148,000	0	yes
T32N-R8E-S24 (B2)	U101	27	1.1	1.1	0.0	0.0	0.0	0.0	0.0	11,000	0	yes
T32N-R8E-S24 (H7)	U102	52	5.0	5.0	0.0	0.0	0.0	0.0	0.0	81,000	0	yes
T32N-R8E-S25 (G2)	U105	24	0.9	0.9	0.0	0.0	0.0	0.0	0.0	2,900	0	yes
T32N-R8E-S36 (G4)	L005	29	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	1	no
T33N-R7E-S5 (H1)	U061	19	0.2	0.2	0.0	0.0	0.0	0.0	0.0	200	0	yes
T33N-R8E-S26 (C7)	U071	30	1.6	1.6	0.0	0.0	0.0	0.0	0.0	21,000	0	yes
T33N-R8E-S27 (G4)	U072	28	1.0	1.0	0.0	0.0	0.0	0.0	0.0	16,000	0	yes
T33N-R8E-S33 (F2)	U074	62	8.6	8.6	0.0	0.0	0.0	0.0	0.0	138,000	0	yes
T33N-R8E-S34 (C6)	U075	34	3.2	3.2	0.0	0.0	0.0	0.0	0.0	7,800	0	yes
T33N-R8E-S35 (C2)	U077	28	1.7	1.7	0.0	0.0	0.0	0.0	0.0	1,800	0	yes
T33N-R8E-S35 (D6)	U078	30	1.7	1.7	0.0	0.0	0.0	0.0	0.0	2,300	0	yes
T33N-R8E-S35 (F2)	U076	29	2.4	2.4	0.0	0.0	0.0	0.0	0.0	12,000	0	yes

County and Location	Mine Index Number	Problem Index Points	Problem Acreage: Total	Gob	Slurry	Tipple	On-site Impound-ment	Off-site Terres-trial	Off-site Aquatic	Gob Volume (Cu. yards)	Problem Openings	Potential Off-site Drainage
GRUNDY (continued)												
T33N-R8E-S36 (G5)	U079	19	1.0	1.0	0.0	0.0	0.0	0.0	0.0	1,300	0	yes
T34N-R7E-S20 (G5)	L017	20	0.5	0.5	0.0	0.0	0.0	0.0	0.0	400	0	yes
T34N-R7E-S32 (A4)	U026	18	0.2	0.2	0.0	0.0	0.0	0.0	0.0	100	0	yes
Total			161.2	121.8	36.7	0.7	2.0	0.0	0.0	1,468,000	4	
HANCOCK												
T3N-R5W-S34 (E2)	L017	19	0.3	0.3	0.0	0.0	0.0	0.0	0.0	4,400	0	no
HENRY												
T14N-R1E-S33 (H1)	S002	93	12.3	6.2	0.0	5.1	1.0	0.0	0.0	265,000	0	no
T15N-R1E-S28 (C1)	L010	31	5.0	5.0	0.0	0.0	0.0	0.0	0.0	16,000	0	yes
T15N-R3E-S6 (A2)	U076	20	0.4	0.3	0.0	0.0	0.1	0.0	0.0	3,900	0	no
T16N-R1E-S3 (D2)	L002	22	3.0	3.0	0.0	0.0	0.0	0.0	0.0	4,800	0	no
T17N-R1E-S21 (C8)	U011	28	0.6	0.6	0.0	0.0	0.0	0.0	0.0	19,000	0	no
T17N-R1E-S21 (G7)	L035	45	0.6	0.3	0.0	0.0	0.0	0.3	0.0	1,500	0	no
T17N-R1E-S22 (H5)	U032	19	0.2	0.2	0.0	0.0	0.0	0.0	0.0	4,800	0	no
T17N-R1E-S32 (D3)	L034	88	7.0	7.0	0.0	0.0	0.0	0.0	0.0	169,000	0	yes
Total			29.1	22.6	0.0	5.1	1.1	0.3	0.0	484,000	0	
JACKSON												
T7S-R1W-S5 (C1)	S002	136	71.2	57.9	2.3	10.0	0.0	1.0	0.0	467,000	0	yes
T7S-R1W-S20 (E5)	L028	129	27.1	17.0	3.9	0.6	1.1	4.5	0.0	549,000	0	yes
T7S-R1W-S29 (H5)	U004	44	9.7	5.3	0.0	0.0	0.0	4.4	0.0	26,000	0	yes
T7S-R1W-S29 (G4)	U005	28	2.2	2.2	0.0	0.0	0.0	0.0	0.0	18,000	0	no
T7S-R3W-S27 (C1)	U088	27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	1	no
T8S-R1W-S5 (F2)	L054	31	3.6	2.4	0.0	0.0	0.0	1.2	0.0	7,700	0	yes
T8S-R1W-S5 (G3)	U008	17	0.5	0.5	0.0	0.0	0.0	0.0	0.0	400	0	no
T8S-R1W-S5 (G3)	L007	21	0.5	0.5	0.0	0.0	0.0	0.0	0.0	800	0	yes
T8S-R1W-S8 (A2)	U052	12	1.1	1.1	0.0	0.0	0.0	0.0	0.0	1,800	0	yes
T8S-R1W-S8 (C3)	U009	44	5.3	3.4	0.0	0.0	0.0	1.9	0.0	38,000	0	yes
T8S-R1W-S8 (E2)	U047	19	2.7	0.0	2.0	0.0	0.0	0.7	0.0	0	0	yes
T8S-R1W-S8 (H2)	U039	34	13.7	2.2	0.0	2.0	9.2	0.3	0.0	7,100	0	no
T8S-R1W-S11 (C1)	U112	29	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	1	no
T8S-R2W-S28 (A6)	U104	26	4.0	4.0	0.0	0.0	0.0	0.0	0.0	3,200	0	no
T9S-R1W-S27 (E6)	U073	22	2.0	2.0	0.0	0.0	0.0	0.0	0.0	3,200	0	yes
T9S-R1W-S27 (H6)	U075	21	3.0	3.0	0.0	0.0	0.0	0.0	0.0	2,400	0	yes
T10S-R1W-S8 (E4)	U157	55	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	1	yes
Total			146.6	101.5	8.2	12.6	10.3	14.0	0.0	1,124,600	3	

County and Location	Mine Index Number	Problem Index Points	Problem Acreage: Total	Gob	Slurry	Tipple	On-site Impound-ment	Off-site Terres-trial	Off-site Aquatic	Gob Volume (Cu. yards)	Problem Openings	Potential Off-site Drainage
JOHNSON												
T11S-R4E-S8 (E2)	U013	29	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	1	no
T11S-R4E-S9 (F4)	U010	55	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	1	yes
Total			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	2	
KANKAKEE												
T31N-R9E-S18 (G5)	U003	30	2.5	2.5	0.0	0.0	0.0	0.0	0.0	12,000	0	yes
T31N-R9E-S30 (H7)	U006	37	2.4	0.9	0.0	0.0	0.0	1.5	0.0	22,000	0	yes
Total			4.9	3.4	0.0	0.0	0.0	1.5	0.0	34,000	0	
KNOX												
T11N-R2E-S16 (D4)	S001	23	3.0	3.0	0.0	0.0	0.0	0.0	0.0	9,700	0	no
T11N-R2E-S25 (H7)	L020	92	10.8	5.5	0.0	2.3	0.0	0.0	3.0	133,000	0	yes
Total			13.8	8.5	0.0	2.3	0.0	0.0	3.0	142,700	0	
LA SALLE												
T29N-R2E-S18 (E5)	U151	101	9.0	5.9	0.0	0.0	0.0	3.1	0.0	619,000	0	no
T29N-R2E-S18 (G7)	U152	21	0.9	0.9	0.0	0.0	0.0	0.0	0.0	15,000	0	no
T31N-R3E-S10 (E6)	U086	99	5.0	4.2	0.0	0.0	0.0	0.8	0.0	301,000	0	no
T31N-R3E-S10 (F7)	U085	63	4.2	4.2	0.0	0.0	0.0	0.0	0.0	203,000	0	no
T31N-R3E-S21 (G1)	U103	39	1.9	1.9	0.0	0.0	0.0	0.0	0.0	31,000	0	no
T31N-R3E-S21 (H1)	U102	38	0.8	0.8	0.0	0.0	0.0	0.0	0.0	32,000	0	no
T31N-R3E-S22 (B1)	U104	77	2.2	1.6	0.0	0.0	0.0	0.6	0.0	103,000	0	yes
T31N-R4E-S19 (C6)	U068	94	8.8	8.8	0.0	0.0	0.0	0.0	0.0	464,000	0	no
T31N-R4E-S19 (C3)	U070	38	5.6	5.6	0.0	0.0	0.0	0.0	0.0	45,000	0	no
T31N-R4E-S19 (C7)	U069	50	2.2	1.4	0.0	0.0	0.0	0.8	0.0	102,000	0	no
T31N-R4E-S20 (B7)	U072	35	2.4	1.9	0.0	0.0	0.0	0.5	0.0	31,000	0	no
T31N-R4E-S31 (C7)	U076	86	6.7	6.7	0.0	0.0	0.0	0.0	0.0	256,000	0	no
T31N-R4E-S31 (H2)	U074	82	7.4	6.6	0.0	0.0	0.0	0.8	0.0	266,000	0	no
T32N-R1E-S4 (C8)	U060	145	12.8	12.8	0.0	0.0	0.0	0.0	0.0	1,240,000	0	yes
T33N-R1E-S3 (H8)	U043	38	6.0	3.0	0.0	0.0	0.0	3.0	0.0	58,000	0	no
T33N-R1E-S14 (C2)	U048	60	5.3	5.3	0.0	0.0	0.0	0.0	0.0	214,000	0	no
T33N-R1E-S14 (H8)	U050	189	16.5	16.5	0.0	0.0	0.0	0.0	0.0	1,730,000	0	yes
T33N-R1E-S15 (B1)	U051	70	13.3	12.2	0.0	1.1	0.0	0.0	0.0	295,000	0	no
T33N-R1E-S16 (A5)	S020	67	6.0	6.0	0.0	0.0	0.0	0.0	0.0	149,000	0	no
T33N-R1E-S16 (C1)	S003	54	1.6	1.6	0.0	0.0	0.0	0.0	0.0	90,000	0	yes

County and Location	Mine Index Number	Problem Index Points	Problem Acreage: Total	Gob	Slurry	Tipple	On-site Impound-ments	Off-site Terres-trial	Off-site Aquatic	Gob Volume (Cu. yards)	Problem Openings	Potential Off-site Drainage
LA SALLE (continued)												
T33N-R1E-S23 (B2)	U057	126	9.4	9.4	0.0	0.0	0.0	0.0	0.0	1,140,000	0	no
T33N-R1E-S25 (E4)	U059	73	5.9	5.9	0.0	0.0	0.0	0.0	0.0	333,000	0	yes
T33N-R2E-S25 (G1)	U031	29	0.5	0.5	0.0	0.0	0.0	0.0	0.0	16,000	0	no
T33N-R2E-S30 (D5)	U041	41	1.9	1.9	0.0	0.0	0.0	0.0	0.0	77,000	0	no
T33N-R2E-S30 (E2)	U040	58	0.8	0.8	0.0	0.0	0.0	0.0	0.0	32,000	0	yes
T33N-R2E-S30 (E4)	U039	55	0.5	0.5	0.0	0.0	0.0	0.0	0.0	22,000	0	yes
T33N-R4E-S25 (H3)	L008	183	8.8	3.9	0.0	0.5	2.2	2.2	0.0	1,851,000	0	no
T33N-R5E-S24 (B3)	U012	20	0.5	0.5	0.0	0.0	0.0	0.0	0.0	3,200	0	no
Total			146.9	131.3	0.0	1.6	2.2	11.8	0.0	9,718,200	0	
LIVINGSTON												
T26N-R6E-S2 (B7)	U004	35	0.5	0.5	0.0	0.0	0.0	0.0	0.0	20,000	0	no
T26N-R6E-S5 (B3)	U001	46	2.5	1.0	0.0	0.0	0.0	1.5	0.0	73,000	0	no
T30N-R3E-S1 (B8)	U015	56	3.9	2.0	0.0	0.0	0.0	0.0	1.9	81,000	0	yes
T30N-R3E-S1 (C2)	U006	47	3.7	3.0	0.0	0.0	0.1	0.6	0.0	121,000	0	no
T30N-R3E-S3 (F3)	L001	37	1.2	1.2	0.0	0.0	0.0	0.0	0.0	48,000	0	no
T30N-R3E-S3 (G4)	U043	28	0.8	0.8	0.0	0.0	0.0	0.0	0.0	19,000	0	no
T30N-R3E-S11 (H8)	U044	31	0.9	0.6	0.0	0.0	0.0	0.3	0.0	19,000	0	no
T30N-R8E-S22 (D2)	U051	113	10.4	5.5	0.0	2.7	0.0	1.7	0.5	374,300	0	no
T30N-R8E-S23 (B8)	U052	31	0.5	0.5	0.0	0.0	0.0	0.0	0.0	28,000	0	no
Total			24.4	15.1	0.0	2.7	0.1	4.1	2.4	783,300	0	
LOGAN												
T19N-R2W-S5 (A4)	L001	21	0.8	0.8	0.0	0.0	0.0	0.0	0.0	3,900	0	no
T20N-R2W-S32 (E8)	U004	16	3.4	3.4	0.0	0.0	0.0	0.0	0.0	5,600	0	no
Total			4.2	4.2	0.0	0.0	0.0	0.0	0.0	9,500	0	

County and Location	Mine Index Number	Problem Index Points	Problem Acreage: Total	Gob	Slurry	Tipple	On-site Impound-ment	Off-site Terres-trial	Off-site Aquatic	Gob Volume (Cu. yards)	Problem Openings	Potential Off-site Drainage
MACOUPIN												
T7N-R6W-S6 (E5)	S007	113	13.7	8.4	0.0	0.0	0.0	5.3	0.0	203,000	0	yes
T7N-R6W-S9 (H4)	S002	207	68.1	53.3	0.0	5.0	0.0	8.7	1.1	859,000	0	yes
T7N-R6W-S21 (A3)	S001	114	34.0	9.8	0.0	3.3	0.0	20.9	0.0	316,000	0	yes
T7N-R6W-S30 (G5)	U024	76	20.4	3.4	5.9	0.0	0.0	11.1	0.0	110,000	0	yes
T7N-R7W-S10 (E3)	S009	212	46.7	31.0	0.0	0.0	0.0	15.7	0.0	1,000,000	0	yes
T7N-R8W-S16 (A2)	U015	20	0.4	0.4	0.0	0.0	0.0	0.0	0.0	3,500	0	no
T7N-R8W-S35 (H4)	U019	14	0.1	0.1	0.0	0.0	0.0	0.0	0.0	500	0	no
T8N-R6W-S7 (G2)	U087	22	0.7	0.7	0.0	0.0	0.0	0.0	0.0	6,400	0	no
T8N-R6W-S9 (G6)	U063	37	8.1	0.6	0.0	0.0	0.0	7.5	0.0	16,000	0	no
T8N-R6W-S17 (B8)	U086	222	58.1	47.6	0.0	0.0	0.0	6.4	4.1	922,000	0	yes
T8N-R6W-S18 (D6)	U089	24	0.5	0.5	0.0	0.0	0.0	0.0	0.0	1,300	1	no
T8N-R6W-S29 (F6)	S006	136	52.7	8.6	0.0	1.4	24.1	18.6	0.0	28,100	0	no
T8N-R7W-S13 (E4)	S003	207	54.9	9.5	16.2	11.4	0.0	17.8	0.0	496,000	0	yes
T9N-R9W-S2 (D8)	U022	24	1.7	0.5	0.0	0.0	0.0	1.2	0.0	8,100	0	no
T10N-R6W-S4 (A5)	S018	50	31.6	3.1	0.0	7.6	0.0	20.9	0.0	4,100	0	no
T10N-R7W-S33 (C7)	S005	34	4.5	4.5	0.0	0.0	0.0	0.0	0.0	14,000	0	no
T10N-R9W-S29 (F2)	U040	16	0.1	0.1	0.0	0.0	0.0	0.0	0.0	200	0	no
T11N-R6W-S5 (A7)	U007	20	0.6	0.6	0.0	0.0	0.0	0.0	0.0	2,900	0	no
T12N-R6W-S8 (A7)	U005	37	11.0	5.1	0.0	0.0	0.0	5.9	0.0	15,000	0	no
T12N-R6W-S9 (H3)	S010	49	13.1	3.0	0.0	1.1	0.0	9.0	0.0	31,000	0	no
Total			421.0	190.8	22.1	29.8	24.1	149.0	5.2	4,037,100	1	
MADISON												
T3N-R7W-S16 (H6)	U061	25	1.8	1.8	0.0	0.0	0.0	0.0	0.0	8,600	0	no
T3N-R8W-S17 (D4)	L002	26	4.1	4.1	0.0	0.0	0.0	0.0	0.0	6,600	0	no
T3N-R8W-S17 (H3)	L003	28	3.4	3.4	0.0	0.0	0.0	0.0	0.0	11,000	0	no
T3N-R8W-S23 (B3)	S007	128	54.5	26.2	15.8	0.0	0.0	12.5	0.0	203,000	0	yes
T3N-R8W-S25 (B8)	S004	218	44.9	21.2	6.4	0.0	0.8	16.5	0.0	1,800,000	0	yes
T3N-R8W-S26 (C6)	U062	25	3.4	3.4	0.0	0.0	0.0	0.0	0.0	5,500	0	no
T3N-R8W-S27 (A4)	U052	37	2.9	2.0	0.0	0.0	0.0	0.9	0.0	65,000	0	no
T3N-R8W-S36 (H1)	U139	21	0.6	0.6	0.0	0.0	0.0	0.0	0.0	2,100	0	no
T4N-R8W-S12 (E6)	L008	22	0.3	0.3	0.0	0.0	0.0	0.0	0.0	400	0	no
T4N-R8W-S29 (F3)	U095	25	0.7	0.7	0.0	0.0	0.0	0.0	0.0	5,600	0	no
T4N-R8W-S29 (H2)	L010	20	0.7	0.7	0.0	0.0	0.0	0.0	0.0	3,400	0	no

County and Location	Mine Index Number	Problem Index Points	Problem Acreage							Gob Volume (Cu. yards)	Problem Openings	Potential Off-site Drainage
			Total	Gob	Slurry	Tipple	On-site Impound-ment	Off-site Terres-trial	Off-site Aquatic			
MADISON (continued)												
T4N-R8W-S34 (B5)	U069	60	6.2	6.2	0.0	0.0	0.0	0.0	0.0	81,000	0	yes
T5N-R9W-S1 (H1)	L024	19	0.5	0.1	0.0	0.0	0.0	0.4	0.0	500	0	no
T6N-R6W-S10 (H8)	S006	349	131.9	76.6	2.8	9.5	21.2	21.8	0.0	1,948,000	0	yes
T6N-R6W-S16 (D2)	S003	53	7.7	4.1	0.5	2.2	0.6	0.3	0.0	66,000	0	yes
T6N-R6W-S18 (F4)	U023	36	3.0	0.9	0.0	0.0	0.0	1.6	0.5	18,000	0	yes
T6N-R7W-S25 (B8)	U097	25	2.0	2.0	0.0	0.0	0.0	0.0	0.0	9,700	0	no
T6N-R9W-S36 (D5)	U065	16	0.1	0.1	0.0	0.0	0.0	0.0	0.0	300	0	no
Total			268.7	154.4	25.5	11.7	22.6	54.0	0.5	4,234,700	0	
MARION												
T2N-R1E-S31 (H2)	S001	14	0.3	0.3	0.0	0.0	0.0	0.0	0.0	500	0	yes
MARSHALL												
T12N-R9E-S2 (A5)	U004	22	0.3	0.3	0.0	0.0	0.0	0.0	0.0	9,700	0	no
T12N-R9E-S2 (B1)	U006	27	0.5	0.5	0.0	0.0	0.0	0.0	0.0	12,000	0	no
T12N-R9E-S2 (H1)	U002	39	1.6	1.5	0.0	0.0	0.0	0.0	0.1	48,000	0	yes
T12N-R9E-S11 (A3)	U009	52	1.7	1.6	0.0	0.0	0.0	0.1	0.0	65,000	0	yes
T12N-R9E-S11 (F2)	L006	31	0.5	0.5	0.0	0.0	0.0	0.0	0.0	24,000	0	yes
T12N-R9E-S11 (F4)	L036	25	0.4	0.4	0.0	0.0	0.0	0.0	0.0	7,700	0	no
T12N-R9E-S11 (H6)	L002	23	0.3	0.3	0.0	0.0	0.0	0.0	0.0	7,300	0	yes
T12N-R9E-S14 (G8)	L004	20	0.2	0.2	0.0	0.0	0.0	0.0	0.0	6,500	0	no
T12N-R9E-S15 (F3)	L022	19	0.2	0.2	0.0	0.0	0.0	0.0	0.0	4,800	0	no
T12N-R9E-S23 (G6)	L008	16	0.2	0.2	0.0	0.0	0.0	0.0	0.0	1,900	0	no
T12N-R9E-S34 (E2)	U024	19	0.2	0.2	0.0	0.0	0.0	0.0	0.0	4,800	0	no
T12N-R9E-S34 (E4)	L017	49	0.3	0.3	0.0	0.0	0.0	0.0	0.0	7,300	1	yes
T13N-R9E-S35 (A1)	L003	19	0.2	0.2	0.0	0.0	0.0	0.0	0.0	2,600	0	no
T13N-R9E-S35 (E1)	U001	21	0.3	0.3	0.0	0.0	0.0	0.0	0.0	4,800	0	no
T29N-R1E-S8 (E4)	U023	55	7.2	7.2	0.0	0.0	0.0	0.0	0.0	139,000	0	no
T29N-R1E-S8 (G4)	U022	121	9.8	9.8	0.0	0.0	0.0	0.0	0.0	949,000	0	no
T29N-R1E-S8 (H4)	U021	162	20.1	16.2	0.0	0.0	0.0	2.0	1.9	1,700,000	0	yes
T30N-R1E-S24 (H1)	U020	122	9.4	9.0	0.0	0.0	0.0	0.4	0.0	944,000	0	no
Total			53.4	48.9	0.0	0.0	0.0	2.5	2.0	3,938,400	1	

County and Location	Mine Index Number	Problem Index Points	Problem Acreage: Total	Gob	Slurry	Tipple	On-site Impound-ments	Off-site Terres-trial	Off-site Aquatic	Gob Volume (Cu. yards)	Problem Openings	Potential Off-site Drainage
MCDONOUGH												
T4N-R3W-S33 (F1)	U023	17	0.3	0.3	0.0	0.0	0.0	0.0	0.0	2,400	0	no
T4N-R3W-S33 (G1)	U024	65	0.5	0.5	0.0	0.0	0.0	0.0	0.0	8,100	1	yes
T4N-R3W-S34 (E8)	L089	29	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	1	no
T4N-R3W-S34 (E8)	L187	21	0.4	0.4	0.0	0.0	0.0	0.0	0.0	7,100	0	no
T5N-R3W-S7 (A3)	U076	24	0.5	0.5	0.0	0.0	0.0	0.0	0.0	9,700	0	no
T5N-R3W-S7 (C5)	U078	36	0.7	0.6	0.0	0.0	0.0	0.0	0.1	11,000	0	yes
T5N-R3W-S7 (G2)	U083	19	0.5	0.5	0.0	0.0	0.0	0.0	0.0	4,000	0	no
T5N-R3W-S7 (H1)	U084	30	1.0	1.0	0.0	0.0	0.0	0.0	0.0	24,000	0	no
T5N-R3W-S8 (E7)	U085	31	1.0	1.0	0.0	0.0	0.0	0.0	0.0	24,000	0	no
T5N-R3W-S8 (F7)	U086	31	1.0	1.0	0.0	0.0	0.0	0.0	0.0	24,000	0	no
T5N-R3W-S18 (F6)	U072	23	0.3	0.3	0.0	0.0	0.0	0.0	0.0	500	0	no
T5N-R4W-S13 (E5)	U063	22	0.3	0.3	0.0	0.0	0.0	0.0	0.0	5,800	0	no
T5N-R4W-S14 (F4)	U052	24	0.5	0.5	0.0	0.0	0.0	0.0	0.0	8,900	0	no
T5N-R4W-S14 (H2)	U056	24	0.5	0.5	0.0	0.0	0.0	0.0	0.0	8,700	0	no
T6N-R4W-S36 (D1)	L046	24	1.0	1.0	0.0	0.0	0.0	0.0	0.0	13,000	0	no
Total			8.5	8.4	0.0	0.0	0.0	0.0	0.1	151,200	2	
MCLEAN												
T23N-R2E-S5 (D4)	U001	33	1.0	1.0	0.0	0.0	0.0	0.0	0.0	16,000	0	no
T24N-R5E-S3 (E4)	U004	28	2.0	2.0	0.0	0.0	0.0	0.0	0.0	26,000	0	yes
T26N-R4E-S1 (B6)	U005	37	1.5	1.5	0.0	0.0	0.0	0.0	0.0	27,000	0	no
Total			4.5	4.5	0.0	0.0	0.0	0.0	0.0	69,000	0	
MENARD												
T17N-R6W-S1 (H1)	U003	20	0.9	0.9	0.0	0.0	0.0	0.0	0.0	2,100	0	no
T17N-R7W-S6 (C4)	U004	24	1.4	0.3	0.0	0.0	0.0	1.1	0.0	3,900	0	no
T17N-R7W-S23 (H5)	L003	31	0.7	0.0	0.0	0.0	0.0	0.7	0.0	0	1	no
T18N-R6W-S36 (F8)	U012	26	3.0	1.5	0.0	0.0	0.0	1.5	0.0	9,600	0	no
T18N-R7W-S36 (C3)	L009	18	0.5	0.5	0.0	0.0	0.0	0.0	0.0	400	0	no
T18N-R7W-S36 (C3)	L011	29	0.9	0.9	0.0	0.0	0.0	0.0	0.0	15,000	0	no
T19N-R6W-S36 (H9)	U001	19	0.6	0.6	0.0	0.0	0.0	0.0	0.0	2,000	0	no
Total			8.0	4.7	0.0	0.0	0.0	3.3	0.0	33,000	1	

County and Location	Mine Index Number	Problem Index Points	Problem Acreage: Total	Gob	Slurry	Tipple	On-site Impound-ment	Off-site Terres-trial	Off-site Aquatic	Gob Volume (Cu. yards)	Problem Openings	Potential Off-site Drainage
MERCER												
T14N-R1W-S26 (B1)	L063	36	7.0	2.0	0.0	4.0	1.0	0.0	0.0	13,000	0	yes
T14N-R2W-S4 (C6)	U070	29	1.0	1.0	0.0	0.0	0.0	0.0	0.0	13,000	0	yes
T14N-R2W-S9 (D7)	U089	30	2.0	2.0	0.0	0.0	0.0	0.0	0.0	16,000	0	yes
T15N-R1W-S4 (G8)	U040	61	10.0	10.0	0.0	0.0	0.0	0.0	0.0	194,000	0	no
T15N-R2W-S27 (A2)	U030	30	4.4	4.4	0.0	0.0	0.0	0.0	0.0	21,000	0	no
T15N-R2W-S27 (B3)	U025	60	3.2	1.6	0.0	1.6	0.0	0.0	0.0	26,000	0	yes
Total			27.6	21.0	0.0	5.6	1.0	0.0	0.0	283,000	0	
MONTGOMERY												
T7N-R3W-S3 (F1)	U015	13	0.2	0.2	0.0	0.0	0.0	0.0	0.0	600	0	no
T7N-R4W-S22 (B4)	U007	57	6.4	6.4	0.0	0.0	0.0	0.0	0.0	103,000	0	yes
T8N-R3W-S35 (A6)	U011	40	6.1	1.4	0.0	0.0	0.0	4.7	0.0	6,800	1	no
T8N-R4W-S12 (H4)	S001	33	6.4	5.5	0.0	0.0	0.9	0.0	0.0	2,700	0	yes
T8N-R4W-S23 (F2)	U009	23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	1	no
T9N-R2W-S6 (D3)	U002	21	0.3	0.1	0.0	0.2	0.0	0.0	0.0	100	0	no
T10N-R2W-S27 (E7)	S003	135	58.0	58.0	0.0	0.0	0.0	0.0	0.0	301,000	0	yes
T12N-R5W-S34 (B3)	S004	207	69.3	63.2	0.0	0.0	6.1	0.0	0.0	1,530,000	0	no
Total			146.7	134.8	0.0	0.2	7.0	4.7	0.0	1,944,200	2	
MORGAN												
T13N-R10W-S30 (C5)	L001	10	0.2	0.2	0.0	0.0	0.0	0.0	0.0	3,500	0	no
PEORIA												
T7N-R6E-S12 (C5)	L129	63	0.2	0.1	0.0	0.0	0.1	0.0	0.0	1,800	1	yes
T7N-R6E-S26 (B7)	L006	31	3.2	1.1	0.0	2.1	0.0	0.0	0.0	21,000	1	no
T7N-R7E-S8 (B1)	S001	140	6.0	6.0	0.0	0.0	0.0	0.0	0.0	971,000	0	yes
T7N-R7E-S8 (B2)	U021	41	2.5	2.5	0.0	0.0	0.0	0.0	0.0	60,000	0	yes
T7N-R7E-S20 (E1)	U026	19	0.1	0.1	0.0	0.0	0.0	0.0	0.0	1,300	0	yes
T8N-R7E-S23 (B2)	L001	32	4.3	4.3	0.0	0.0	0.0	0.0	0.0	35,000	0	no
T9N-R5E-S17 (E6)	U027	58	3.0	3.0	0.0	0.0	0.0	0.0	0.0	181,000	0	no
T9N-R6E-S15 (B2)	L068	27	1.7	1.7	0.0	0.0	0.0	0.0	0.0	14,000	0	yes

County and Location	Mine Index Number	Problem Index Points	Problem Acreage: Total	Gob	Slurry	Tipple	On-site Impound-ment	Off-site Terres-trial	Off-site Aquatic	Gob Volume (Cu. yards)	Problem Openings	Potential Off-site Drainage
PEORIA (continued)												
T9N-R6E-S15 (F5)	L065	24	2.2	2.2	0.0	0.0	0.0	0.0	0.0	7,100	0	yes
T9N-R6E-S24 (B7)	S004	66	2.2	2.2	0.0	0.0	0.0	0.0	0.0	11,000	1	yes
T9N-R7E-S22 (H4)	L010	26	2.1	2.1	0.0	0.0	0.0	0.0	0.0	17,000	0	no
T9N-R7E-S27 (A6)	L033	59	3.0	3.0	0.0	0.0	0.0	0.0	0.0	24,000	0	yes
T9N-R7E-S33 (H3)	L032	29	6.0	0.0	0.0	6.0	0.0	0.0	0.0	0	1	no
T9N-R7E-S34 (E1)	L008	20	2.1	2.1	0.0	0.0	0.0	0.0	0.0	3,200	0	no
T9N-R7E-S34 (H6)	L125	15	2.1	0.0	0.0	2.1	0.0	0.0	0.0	0	0	yes
T10N-R6E-S26 (F3)	L117	18	0.2	0.2	0.0	0.0	0.0	0.0	0.0	600	0	yes
Total			40.9	30.6	0.0	10.2	0.1	0.0	0.0	1,348,000	4	
PERRY												
T4S-R1W-S29 (B3)	S010	30	1.7	0.5	0.0	0.7	0.0	0.5	0.0	4,000	0	no
T5S-R1W-S20 (D8)	U032	15	10.0	1.0	6.0	0.0	0.0	3.0	0.0	800	0	no
T5S-R1W-S30 (H2)	S001	31	2.5	1.3	0.0	0.0	0.0	1.2	0.0	4,200	0	yes
T5S-R1W-S32 (C8)	U035	35	2.8	2.0	0.0	0.0	0.0	0.8	0.0	32,000	0	no
T5S-R3W-S13 (A6)	S003	23	0.9	0.9	0.0	0.0	0.0	0.0	0.0	200	0	no
T6S-R1W-S5 (A3)	L031	17	0.5	0.4	0.0	0.0	0.0	0.1	0.0	100	0	yes
T6S-R1W-S6 (C7)	U063	18	0.8	0.8	0.0	0.0	0.0	0.0	0.0	2,600	0	no
T6S-R1W-S8 (H7)	U076	26	7.0	1.3	0.0	5.7	0.0	0.0	0.0	200	0	yes
T6S-R1W-S19 (E4)	U103	43	9.8	5.8	0.0	0.0	0.0	4.0	0.0	28,000	0	yes
T6S-R1W-S23 (E8)	S006	337	204.1	47.8	36.9	15.8	20.6	73.0	10.0	1,160,000	0	yes
T6S-R2W-S2 (G7)	U051	18	0.6	0.6	0.0	0.0	0.0	0.0	0.0	2,900	0	no
T6S-R2W-S36 (H8)	S032	39	14.1	7.5	6.6	0.0	0.0	0.0	0.0	3,000	0	yes
T6S-R3W-S2 (G6)	U049	16	15.1	14.0	0.0	0.0	0.0	0.0	1.1	1,800	0	no
Total			269.9	83.9	49.5	22.2	20.6	82.6	11.1	1,239,800	0	
PUTNAM												
T32N-R1W-S8 (G2)	S001	334	39.3	37.3	0.0	2.0	0.0	0.0	0.0	2,364,000	0	no
T32N-R1W-S11 (B1)	U001	177	24.8	19.3	0.0	5.5	0.0	0.0	0.0	1,860,000	0	no
Total			64.1	56.6	0.0	7.5	0.0	0.0	0.0	4,224,000	0	

County and Location	Mine Index Number	Problem Index Points	Problem Acreage: Total	Gob	Slurry	Tipple	On-site Impound-ment	Off-site Terres-trial	Off-site Aquatic	Gob Volume (Cu. yards)	Problem Openings	Potential Off-site Drainage
RANDOLPH												
T4S-R5W-S6 (G7)	S004	19	0.2	0.2	0.0	0.0	0.0	0.0	0.0	2,600	0	no
T4S-R5W-S10 (E6)	S006	93	26.8	19.1	2.8	2.7	0.0	2.2	0.0	143,800	0	yes
T5S-R5W-S8 (E5)	S005	348	171.1	74.2	64.3	0.0	20.0	12.6	0.0	903,000	0	yes
T5S-R6W-S1 (B6)	S003	26	6.3	6.3	0.0	0.0	0.0	0.0	0.0	4,800	0	yes
T5S-R6W-S2 (A1)	U027	30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	1	yes
T5S-R6W-S2 (G5)	U029	33	0.6	0.6	0.0	0.0	0.0	0.0	0.0	100	1	yes
T5S-R6W-S9 (G7)	U034	42	0.1	0.1	0.0	0.0	0.0	0.0	0.0	300	0	yes
T5S-R6W-S27 (B2)	L002	43	1.0	1.0	0.0	0.0	0.0	0.0	0.0	500	0	yes
T6S-R5W-S11 (C6)	U073	22	0.4	0.4	0.0	0.0	0.0	0.0	0.0	4,500	0	yes
Total			206.5	101.9	67.1	2.7	20.0	14.8	0.0	1,058,800	2	
ROCK ISLAND												
T16N-R1W-S1 (E2)	L001	66	1.9	1.9	0.0	0.0	0.0	0.0	0.0	46,000	0	yes
T17N-R1W-S25 (F3)	L002	55	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	2	yes
T17N-R1W-S36 (G6)	U030	19	0.3	0.3	0.0	0.0	0.0	0.0	0.0	1,000	0	no
Total			2.2	2.2	0.0	0.0	0.0	0.0	0.0	47,000	2	
SALINE												
T8S-R5E-S27 (A3)	S005	384	149.7	117.3	0.0	0.0	21.5	10.9	0.0	1,890,000	0	yes
T8S-R5E-S31 (H8)	S046	48	15.3	12.7	0.0	0.0	0.0	2.6	0.0	32,700	0	yes
T8S-R6E-S36 (G1)	S012	55	35.6	17.5	0.0	18.1	0.0	0.0	0.0	7,100	0	yes
T9S-R5E-S5 (D1)	S043	20	12.8	0.0	0.0	12.8	0.0	0.0	0.0	0	1	no
T9S-R5E-S13 (A8)	S039	54	70.2	31.2	0.0	39.0	0.0	0.0	0.0	5,000	0	yes
T9S-R5E-S33 (C2)	S011	37	6.5	6.5	0.0	0.0	0.0	0.0	0.0	400	0	yes
T9S-R5E-S34 (C3)	U068	23	2.3	2.3	0.0	0.0	0.0	0.0	0.0	1,900	0	yes
T9S-R5E-S34 (E4)	L014	33	4.4	4.4	0.0	0.0	0.0	0.0	0.0	11,000	0	yes
T9S-R5E-S36 (A8)	U008	28	2.0	2.0	0.0	0.0	0.0	0.0	0.0	1,100	0	yes
T9S-R6E-S2 (C7)	S010	41	15.0	10.6	0.0	4.4	0.0	0.0	0.0	4,300	0	yes
T9S-R6E-S2 (G2)	S007	43	26.0	22.0	0.0	4.0	0.0	0.0	0.0	11,000	0	yes
T9S-R6E-S15 (A6)	S008	35	10.0	10.0	0.0	0.0	0.0	0.0	0.0	8,000	0	yes
T9S-R6E-S21 (C4)	U015	21	3.0	0.0	0.0	3.0	0.0	0.0	0.0	0	0	no
T9S-R6E-S27 (E2)	S015	29	4.6	4.6	0.0	0.0	0.0	0.0	0.0	1,300	0	yes
T9S-R6E-S31 (G2)	U070	57	0.3	0.0	0.0	0.0	0.0	0.3	0.0	0	1	yes
T9S-R7E-S1 (D7)	L089	18	0.2	0.2	0.0	0.0	0.0	0.0	0.0	100	0	yes

County and Location	Mine Index Number	Problem Index Points	Problem Acreage: Total	Gob	Slurry	Tipple	On-site Impound-ment	Off-site Terres-trial	Off-site Aquatic	Gob Volume (Cu. yards)	Problem Openings	Potential Off-site Drainage
SALINE (continued)												
T9S-R7E-S1 (E5)	U059	20	1.2	1.2	0.0	0.0	0.0	0.0	0.0	500	0	yes
T9S-R7E-S14 (B1)	U042	19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	1	no
T10S-R7E-S13 (B1)	U060	24	1.0	1.0	0.0	0.0	0.0	0.0	0.0	300	1	yes
T10S-R7E-S13 (E1)	L044	45	2.8	0.0	0.0	0.0	0.0	2.8	0.0	0	1	yes
Total			362.9	243.5	0.0	81.3	21.5	16.6	0.0	1,974,700	5	
SANGAMON												
T13N-R6W-S34 (H7)	S010	24	4.0	3.0	0.0	1.0	0.0	0.0	0.0	4,800	0	no
T14N-R6W-S13 (F1)	U021	22	0.2	0.2	0.0	0.0	0.0	0.0	0.0	300	0	no
T16N-R4W-S10 (D5)	S021	28	3.1	2.0	0.0	1.1	0.0	0.0	0.0	14,000	0	no
T16N-R4W-S12 (A5)	L015	16	2.0	2.0	0.0	0.0	0.0	0.0	0.0	100	0	no
T16N-R5W-S13 (C7)	S007	80	22.2	20.2	0.0	0.0	2.0	0.0	0.0	205,000	0	no
T16N-R5W-S24 (D5)	U009	34	19.2	19.2	0.0	0.0	0.0	0.0	0.0	5,200	0	no
T17N-R4W-S17 (F6)	U019	23	4.9	4.9	0.0	0.0	0.0	0.0	0.0	5,900	0	no
T17N-R4W-S35 (A7)	U031	28	2.5	2.5	0.0	0.0	0.0	0.0	0.0	16,000	0	no
T17N-R5W-S16 (G5)	L007	24	1.0	1.0	0.0	0.0	0.0	0.0	0.0	8,900	0	no
T17N-R7W-S35 (E8)	L005	20	0.6	0.6	0.0	0.0	0.0	0.0	0.0	4,200	0	no
T17N-R5W-S6 (H2)	L004	19	0.4	0.4	0.0	0.0	0.0	0.0	0.0	2,700	0	no
Total			60.1	56.0	0.0	2.1	2.0	0.0	0.0	267,100	0	
SCHUYLER												
T1N-R1E-S4 (B7)	U032	25	0.5	0.5	0.0	0.0	0.0	0.0	0.0	4,000	0	no
T2N-R1W-S12 (F4)	U043	15	0.2	0.2	0.0	0.0	0.0	0.0	0.0	700	0	no
T2N-R1W-S20 (A7)	U029	17	0.3	0.3	0.0	0.0	0.0	0.0	0.0	1,500	0	yes
T2N-R1W-S22 (F3)	L006	47	5.3	5.3	0.0	0.0	0.0	0.0	0.0	68,000	0	yes
T2N-R1W-S26 (D8)	U010	20	0.1	0.1	0.0	0.0	0.0	0.0	0.0	800	0	yes
T2N-R1W-S26 (F2)	L004	20	0.3	0.3	0.0	0.0	0.0	0.0	0.0	2,400	0	yes
T3N-R1W-S26 (C1)	U056	21	0.8	0.3	0.0	0.5	0.0	0.0	0.0	1,900	0	no
T3N-R2W-S6 (A7)	U041	15	0.2	0.2	0.0	0.0	0.0	0.0	0.0	1,000	0	no
T3N-R2W-S7 (H8)	L078	15	0.2	0.2	0.0	0.0	0.0	0.0	0.0	700	0	no
T3N-R2W-S12 (G3)	U044	18	1.0	1.0	0.0	0.0	0.0	0.0	0.0	3,200	0	no
T3N-R3W-S14 (A4)	L012	30	1.0	1.0	0.0	0.0	0.0	0.0	0.0	19,000	0	yes
T3N-R3W-S14 (A5)	L009	16	0.2	0.2	0.0	0.0	0.0	0.0	0.0	300	0	no
T3N-R3W-S14 (B3)	U035	21	0.3	0.3	0.0	0.0	0.0	0.0	0.0	7,300	0	no
T3N-R3W-S24 (C4)	L068	17	0.1	0.1	0.0	0.0	0.0	0.0	0.0	300	0	yes
T3N-R3W-S24 (C6)	L007	13	0.6	0.1	0.0	0.5	0.0	0.0	0.0	200	0	no
Total			11.1	10.1	0.0	1.0	0.0	0.0	0.0	111,300	0	

County and Location	Mine Index Number	Problem Index Points	Problem Acreage: Total	Gob	Slurry	Tipple	On-site Impound-ment	Off-site Terres-trial	Off-site Aquatic	Gob Volume (Cu. yards)	Problem Openings	Potential Off-site Drainage
SCOTT												
T13N-R12W-S15 (B1)	L007	13	0.2	0.2	0.0	0.0	0.0	0.0	0.0	100	0	no
SHELBY												
T11N-R2E-S23 (F7)	U001	37	11.4	2.6	1.1	0.0	0.0	7.7	0.0	12,000	0	no
STARK												
T12N-R5E-S19 (C5)	U010	58	0.2	0.1	0.0	0.0	0.0	0.0	0.1	200	1	yes
T14N-R6E-S15 (B5)	L003	20	0.5	0.5	0.0	0.0	0.0	0.0	0.0	4,800	0	no
T14N-R6E-S16 (A2)	L013	22	1.0	1.0	0.0	0.0	0.0	0.0	0.0	8,100	0	no
Total			1.7	1.6	0.0	0.0	0.0	0.0	0.1	13,100	1	
ST. CLAIR												
T1N-R6W-S32 (H8)	L007	26	1.5	1.5	0.0	0.0	0.0	0.0	0.0	400	0	yes
T1N-R7W-S18 (E7)	S017	34	2.5	2.5	0.0	0.0	0.0	0.0	0.0	20,000	0	yes
T1N-R7W-S35 (D3)	U182	58	10.0	6.0	0.0	0.0	0.0	4.0	0.0	68,000	0	yes
T1N-R8W-S26 (F1)	L070	29	4.5	4.5	0.0	0.0	0.0	0.0	0.0	3,600	0	yes
T1N-R8W-S27 (D1)	U137	24	0.2	0.2	0.0	0.0	0.0	0.0	0.0	100	0	yes
T1N-R8W-S29 (E3)	U151	12	0.5	0.5	0.0	0.0	0.0	0.0	0.0	100	0	yes
T1N-R8W-S33 (H6)	S025	24	0.2	0.2	0.0	0.0	0.0	0.0	0.0	100	0	yes
T1N-R9W-S11 (E7)	L020	21	0.5	0.5	0.0	0.0	0.0	0.0	0.0	800	0	yes
T1S-R7W-S18 (C5)	S007	37	8.0	8.0	0.0	0.0	0.0	0.0	0.0	13,000	0	yes
T1S-R7W-S20 (D4)	L011	17	1.0	1.0	0.0	0.0	0.0	0.0	0.0	100	0	yes
T2N-R8W-S10 (D5)	U023	89	11.1	11.1	0.0	0.0	0.0	0.0	0.0	269,000	0	yes
T2N-R8W-S17 (F2)	L016	24	0.1	0.1	0.0	0.0	0.0	0.0	0.0	100	0	yes
T2N-R8W-S25 (F6)	U031	25	2.8	2.8	0.0	0.0	0.0	0.0	0.0	4,500	0	yes
T2N-R8W-S26 (A3)	S010	360	171.3	96.3	75.0	0.0	0.0	0.0	0.0	1,860,000	0	yes
T2N-R8W-S32 (D3)	U036	16	0.1	0.1	0.0	0.0	0.0	0.0	0.0	100	0	yes
T2N-R8W-S33 (E3)	S013	126	34.9	26.9	6.5	0.0	1.5	0.0	0.0	434,000	0	yes
T2S-R7W-S35 (D7)	L003	22	2.0	2.0	0.0	0.0	0.0	0.0	0.0	800	0	yes
T3S-R6W-S26 (A7)	S008	22	4.0	4.0	0.0	0.0	0.0	0.0	0.0	1,100	0	yes
T3S-R6W-S28 (H1)	U239	27	6.4	6.4	0.0	0.0	0.0	0.0	0.0	5,200	0	yes
Total			261.6	174.6	81.5	0.0	1.5	4.0	0.0	2,681,000	0	

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TAZEWELL												
T24N-R4W-S6 (E8)	U001	26	0.9	0.9	0.0	0.0	0.0	0.0	0.0	2,900	0	no
T25N-R4W-S7 (E8)	U007	18	0.9	0.9	0.0	0.0	0.0	0.0	0.0	2,900	0	no
T25N-R5W-S24 (C2)	L002	19	0.8	0.6	0.0	0.2	0.0	0.0	0.0	1,000	0	yes
Total			2.6	2.4	0.0	0.2	0.0	0.0	0.0	6,800	0	
VERMILION												
T18N-R11W-S3 (E6)	U200	55	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	1	yes
T18N-R11W-S5 (B5)	U155	29	2.1	2.1	0.0	0.0	0.0	0.0	0.0	6,800	0	no
T18N-R11W-S9 (D1)	U159	32	1.9	1.9	0.0	0.0	0.0	0.0	0.0	15,000	0	yes
T18N-R12W-S3 (C4)	U140	36	2.0	2.0	0.0	0.0	0.0	0.0	0.0	32,000	0	yes
T18N-R12W-S15 (B3)	S002	335	89.7	79.2	10.5	0.0	0.0	0.0	0.0	2,400,000	0	yes
T18N-R12W-S26 (D2)	S001	105	23.4	17.5	0.0	5.9	0.0	0.0	0.0	565,000	0	yes
T19N-R11W-S17 (C1)	U084	17	0.3	0.3	0.0	0.0	0.0	0.0	0.0	200	0	yes
T19N-R11W-S17 (C8)	U092	36	2.8	2.8	0.0	0.0	0.0	0.0	0.0	9,000	0	yes
T19N-R11W-S19 (A3)	L006	18	2.5	2.5	0.0	0.0	0.0	0.0	0.0	4,000	0	yes
T19N-R11W-S19 (F6)	S004	35	4.4	4.4	0.0	0.0	0.0	0.0	0.0	3,600	0	yes
T19N-R11W-S30 (F1)	L220	75	13.5	10.4	0.0	3.1	0.0	0.0	0.0	168,000	0	yes
T19N-R11W-S33 (F6)	U124	59	0.4	0.0	0.0	0.0	0.0	0.0	0.4	0	1	yes
T19N-R12W-S8 (D3)	U017	27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	2	no
T19N-R12W-S10 (C2)	L010	26	0.8	0.8	0.0	0.0	0.0	0.0	0.0	700	0	yes
T19N-R12W-S15 (A6)	L013	19	1.6	1.6	0.0	0.0	0.0	0.0	0.0	1,300	0	yes
T19N-R12W-S20 (A1)	L034	22	1.6	1.6	0.0	0.0	0.0	0.0	0.0	3,900	0	yes
T19N-R12W-S21 (G8)	L066	34	1.5	1.5	0.0	0.0	0.0	0.0	0.0	1,200	1	yes
T19N-R12W-S22 (D1)	L011	20	1.5	1.5	0.0	0.0	0.0	0.0	0.0	1,200	0	yes
T19N-R12W-S22 (D3)	L185	22	1.4	1.4	0.0	0.0	0.0	0.0	0.0	3,400	0	yes
T19N-R12W-S22 (E3)	L022	62	3.5	2.5	0.0	1.0	0.0	0.0	0.0	2,000	1	yes
T19N-R12W-S22 (H2)	U172	18	0.8	0.8	0.0	0.0	0.0	0.0	0.0	400	0	yes
T19N-R12W-S22 (H2)	L027	55	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	1	yes
T19N-R12W-S22 (H3)	L016	23	2.4	2.4	0.0	0.0	0.0	0.0	0.0	3,900	0	yes
T19N-R12W-S22 (H4)	L209	32	2.2	2.2	0.0	0.0	0.0	0 0	0.0	900	1	yes
T19N-R12W-S23 (G7)	L005	21	1.8	1.8	0.0	0.0	0.0	0.0	0.0	1,500	0	yes
T19N-R12W-S27 (G6)	L020	21	3.1	3.1	0.0	0.0	0.0	0.0	0.0	1,600	0	yes
T19N-R12W-S30 (G3)	L007	33	10.5	3.0	0.0	7.5	0.0	0.0	0.0	9,700	0	yes
T19N-R13W-S16 (H8)	U005	28	0.7	0.7	0.0	0.0	0.0	0.0	0.0	6,100	0	yes
T19N-R13W-S34 (F1)	U008	21	1.2	1.2	0.0	0.0	0.0	0.0	0.0	5,800	0	yes
Total			177.6	149.2	10.5	17.5	0.0	0.0	0.4	3,247,200	8	

County and Location	Mine Index Number	Problem Index Points	Problem Acreage: Total	Gob	Slurry	Tipple	On-site Impound-ment	Off-site Terres-trial	Off-site Aquatic	Gob Volume (Cu. yards)	Problem Openings	Potential Off-site Drainage
WARREN												
T12N-R2W-S14 (B1)	U014	45	1.4	0.0	0.0	0.0	0.0	1.4	0.0	0	1	yes
WASHINGTON												
T2S-R3W-S13 (B3)	S002	32	4.7	1.2	3.5	0.0	0.0	0.0	0.0	15,000	0	yes
WHITE												
T6S-R8E-S21 (E7)	S001	28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	1	no
WILL												
T32N-R9E-S4 (H8)	U019	19	3.1	3.1	0.0	0.0	0.0	0.0	0.0	1,500	0	yes
T32N-R9E-S5 (D7)	U012	39	3.1	3.1	0.0	0.0	0.0	0.0	0.0	40,000	0	yes
T32N-R9E-S5 (E3)	U015	36	2.7	2.7	0.0	0.0	0.0	0.0	0.0	35,000	0	yes
T32N-R9E-S6 (B3)	U011	43	5.1	5.1	0.0	0.0	0.0	0.0	0.0	49,000	0	yes
T32N-R9E-S6 (F6)	U009	32	2.4	2.4	0.0	0.0	0.0	0.0	0.0	19,000	0	yes
T32N-R9E-S6 (G2)	U010	29	1.1	1.1	0.0	0.0	0.0	0.0	0.0	14,000	0	yes
T32N-R9E-S7 (B3)	U023	21	1.5	1.5	0.0	0.0	0.0	0.0	0.0	4,800	0	yes
T32N-R9E-S7 (B6)	U022	28	0.8	0.8	0.0	0.0	0.0	0.0	0.0	2,600	0	yes
T32N-R9E-S7 (F2)	U021	37	1.2	1.2	0.0	0.0	0.0	0.0	0.0	15,000	0	yes
T32N-R9E-S17 (D5)	U031	83	36.5	17.0	15.2	2.9	0.0	0.0	1.4	14,000	1	yes
T32N-R9E-S18 (E6)	U029	22	0.9	0.9	0.0	0.0	0.0	0.0	0.0	1,500	0	yes
T32N-R9E-S19 (B6)	U032	34	1.8	1.8	0.0	0.0	0.0	0.0	0.0	29,000	0	yes
T32N-R9E-S31 (C6)	U035	55	3.2	2.8	0.0	0.4	0.0	0.0	0.0	45,000	1	yes
T33N-R9E-S31 (C3)	U003	25	0.2	0.2	0.0	0.0	0.0	0.0	0.0	3,200	0	yes
T33N-R9E-S32 (A5)	U007	42	2.8	2.8	0.0	0.0	0.0	0.0	0.0	45,000	0	yes
Total			66.4	46.5	15.2	3.3	0.0	0.0	1.4	318,600	2	
WILLIAMSON												
T8S-R1E-S1 (E6)	U187	13	5.0	0.0	0.0	5.0	0.0	0.0	0.0	0	0	no
T8S-R1E-S8 (H8)	U181	46	9.0	2.0	0.0	4.0	0.0	3.0	0.0	16,000	0	yes
T8S-R1E-S11 (H4)	S088	122	132.0	10.0	93.0	11.0	0.0	18.0	0.0	48,000	0	yes
T8S-R1E-S14 (C7)	U184	48	14.5	3.0	0.0	6.0	0.0	5.5	0.0	39,000	0	yes
T8S-R1E-S20 (B3)	U004	43	8.9	8.1	0.0	0.0	0.0	0.8	0.0	26,000	0	no
T8S-R1E-S25 (G4)	U035	83	28.6	8.3	0.0	0.0	0.0	20.3	0.0	107,000	0	yes
T8S-R1E-S29 (B3)	L147	31	3.8	3.6	0.0	0.0	0.0	0.2	0.0	17,000	0	no

County and Location	Mine Index Number	Problem Index Points	Problem Acreage: Total	Gob	Slurry	Tipple	On-site Impound-ment	Off-site Terres-trial	Off-site Aquatic	Gob Volume (Cu. yards)	Problem Openings	Potential Off-site Drainage
WILLIAMSON (continued)												
T8S-R1E-S35 (G8)	U032	45	10.6	9.0	0.0	0.0	0.0	1.6	0.0	73,000	0	no
T8S-R1E-S36 (F4)	U034	41	3.8	3.3	0.0	0.0	0.0	0.0	0.5	27,000	0	yes
T8S-R2E-S5 (D6)	S009	30	11.0	4.0	0.0	7.0	0.0	0.0	0.0	13,000	0	no
T8S-R2E-S10 (E8)	S093	192	120.5	32.0	3.0	16.8	43.9	20.8	4.0	310,000	0	no
T8S-R2E-S11 (D5)	U204	35	12.9	3.0	0.0	9.9	0.0	0.0	0.0	2,400	0	yes
T8S-R2E-S12 (A5)	U203	25	22.9	20.9	0.0	2.0	0.0	0.0	0.0	2,700	0	no
T8S-R2E-S17 (G3)	U193	113	35.6	35.6	0.0	0.0	0.0	0.0	0.0	345,000	0	no
T8S-R2E-S19 (F7)	U186	41	13.9	2.0	0.0	4.0	0.0	7.9	0.0	19,000	0	yes
T8S-R2E-S20 (B4)	S003	66	20.9	9.0	0.0	6.0	0.0	5.9	0.0	44,000	0	yes
T8S-R2E-S21 (G3)	S020	50	25.9	9.0	0.0	5.0	1.0	10.9	0.0	29,000	0	no
T8S-R2E-S24 (A1)	U205	38	14.9	14.9	0.0	0.0	0.0	0.0	0.0	4,100	1	no
T8S-R2E-S31 (E5)	U050	57	12.5	5.5	0.0	0.0	0.0	7.0	0.0	44,000	0	yes
T8S-R2E-S36 (F1)	U063	35	4.2	2.2	0.0	0.0	0.0	2.0	0.0	7,100	0	yes
T8S-R3E-S28 (E7)	U078	18	0.5	0.5	0.0	0.0	0.0	0.0	0.0	500	0	yes
T8S-R3E-S31 (G5)	U076	19	5.3	0.2	0.0	4.6	0.0	0.4	0.1	300	0	no
T8S-R3E-S34 (D5)	S008	30	1.0	1.0	0.0	0.0	0.0	0.0	0.0	800	1	no
T9S-R1E-S11 (G7)	L135	26	4.7	4.7	0.0	0.0	0.0	0.0	0.0	1,500	0	no
T9S-R1E-S31 (D6)	L178	18	1.1	0.6	0.0	0.0	0.0	0.5	0.0	1,000	0	no
T9S-R2E-S2 (E2)	U065	31	3.7	3.7	0.0	0.0	0.0	0.0	0.0	12,000	0	yes
T9S-R3E-S6 (C5)	L002	21	0.8	0.8	0.0	0.0	0.0	0.0	0.0	100	0	yes
T9S-R3E-S6 (D2)	L048	67	16.5	13.5	0.0	0.0	0.0	1.3	1.7	22,000	0	no
T9S-R3E-S6 (D7)	L162	20	1.1	0.1	0.0	0.0	0.0	1.0	0.0	1,000	0	no
T9S-R3E-S11 (B4)	L003	10	1.4	1.4	0.0	0.0	0.0	0.0	0.0	2,300	0	no
T9S-R3E-S11 (E6)	S104	20	1.4	1.4	0.0	0.0	0.0	0.0	0.0	2,300	0	no
T9S-R3E-S13 (A4)	L150	97	31.1	18.9	3.3	0.0	0.0	8.9	0.0	152,000	0	yes
T9S-R3E-S20 (H8)	U293	11	0.3	0.1	0.0	0.0	0.0	0.2	0.0	100	0	no
T9S-R3E-S23 (H1)	L155	41	8.9	6.6	0.0	0.0	0.0	2.3	0.0	5,500	0	yes
T9S-R3E-S24 (D1)	L136	22	2.2	1.6	0.0	0.0	0.0	0.6	0.0	1,300	0	yes
T9S-R3E-S24 (H2)	L151	36	4.4	4.4	0.0	0.0	0.0	0.0	0.0	18,000	0	yes
T9S-R3E-S24 (H3)	L109	27	5.4	1.7	0.0	0.0	0.0	3.7	0.0	2,700	0	yes
T9S-R3E-S24 (H7)	L033	59	12.9	4.8	0.0	4.2	0.0	3.9	0.0	15,000	1	yes
T9S-R3E-S25 (B1)	L063	12	1.9	1.9	0.0	0.0	0.0	0.0	0.0	1,500	0	yes
T9S-R4E-S10 (A6)	L179	12	1.0	0.0	0.0	1.0	0.0	0.0	0.0	0	0	no
T9S-R4E-S17 (D8)	L177	84	16.7	12.9	0.6	0.0	1.4	1.8	0.0	83,000	2	yes
T9S-R4E-S19 (G8)	L088	31	7.0	4.1	0.0	0.0	0.0	2.9	0.0	6,600	0	yes
T9S-R4E-S19 (H9)	L101	24	2.2	2.2	0.0	0.0	0.0	0.0	0.0	1,800	0	yes
T9S-R4E-S20 (G5)	L190	35	5.3	5.3	0.0	0.0	0.0	0.0	0.0	8,600	0	yes
T9S-R4E-S27 (D5)	L142	20	1.3	1.3	0.0	0.0	0.0	0.0	0.0	400	0	yes
T9S-R4E-S27 (E4)	S084	44	5.8	4.7	1.1	0.0	0.0	0.0	0.0	38,000	0	yes

County and Location	Mine Index Number	Problem Index Points	Problem Acreage: Total	Gob	Slurry	Tipple	On-site Impound-ment	Off-site Terres-trial	Off-site Aquatic	Gob Volume (Cu. yards)	Problem Openings	Potential Off-site Drainage
WILLIAMSON (continued)												
T9S-R4E-S27 (E5)	L141	32	3.5	2.9	0.0	0.0	0.0	0.6	0.0	9,400	0	yes
T9S-R4E-S29 (A1)	L014	27	0.2	0.0	0.0	0.2	0.0	0.0	0.0	0	1	no
T9S-R4E-S29 (D6)	L032	50	10.9	5.9	0.0	2.2	0.0	2.8	0.0	38,000	0	yes
T9S-R4E-S30 (B2)	L066	41	2.6	1.8	0.0	0.0	0.0	0.8	0.0	2,900	1	yes
T9S-R4E-S30 (C1)	L018	36	1.6	1.6	0.0	0.0	0.0	0.0	0.0	1,300	1	yes
T9S-R4E-S30 (C3)	L007	28	5.6	5.6	0.0	0.0	0.0	0.0	0.0	9,000	0	yes
T9S-R4E-S30 (C8)	L058	31	4.8	4.6	0.0	0.0	0.2	0.0	0.0	3,700	1	yes
T9S-R4E-S30 (E2)	L020	44	6.7	5.7	0.0	0.0	0.0	1.0	0.0	18,000	0	yes
T9S-R4E-S30 (G2)	L042	38	5.2	3.5	0.0	0.0	0.0	1.7	0.0	11,000	0	yes
T9S-R4E-S31 (F2)	L208	39	1.4	1.2	0.0	0.0	0.0	0.2	0.0	1,000	1	yes
T9S-R4E-S34 (D5)	L169	21	1.8	1.8	0.0	0.0	0.0	0.0	0.0	1,500	0	yes
T9S-R4E-S34 (H4)	U164	35	4.1	3.9	0.0	0.0	0.0	0.2	0.0	6,300	0	yes
T9S-R4E-S34 (H5)	L024	26	3.1	3.1	0.0	0.0	0.0	0.0	0.0	5,000	0	no
T9S-R4E-S35 (A6)	L041	9	0.3	0.3	0.0	0.0	0.0	0.0	0.0	300	0	yes
Total			707.1	325.7	101.0	88.9	46.5	138.7	6.3	1,659,000	10	
WOODFORD												
T27N-R1W-S14 (B7)	S001	116	11.7	9.3	0.0	0.6	0.0	1.8	0.0	750,000	0	yes
T28N-R2W-S6 (F4)	S002	154	19.0	11.8	0.0	3.5	1.0	2.7	0.0	1,430,000	0	no
T28N-R2W-S7 (H3)	U001	107	6.9	5.5	0.0	0.0	0.1	1.0	0.3	399,000	1	no
Total			37.6	26.6	0.0	4.1	1.1	5.5	0.3	2,579,000	1	
State Total			5,001.4	2,846.6	666.8	432.8	197.5	821.5	36.2	68,510,000	70	
Percent of Total Problem Acreage				56.9	13.3	8.7	4.0	16.4	0.7			

[a] Notation inside parentheses specifies part of section (see Appendix A).

[b] According to Illinois Department of Mines and Minerals, L denotes local; S denotes shipping, U denotes unclassified.

[c] Represents the total problem index points based on an evaluation of problem conditions and environmental locale of the mine site (see Appendix J and K).

[d] Includes potentially hazardous openings or openings with mine drainage.

[e] Represents potential off-site drainage to adjacent ditch, stream, or river.

APPENDIX J

PROBLEM INDICES (PI) USED IN THE EVALUATION OF POTENTIAL PROBLEM MINE SITES IN ILLINOIS COUNTIES[a]

Problem Index	Problem Condition
PI1	Hazardous openings
PI2	Mine drainage to adjacent waterways and off-site terrestrial areas based on type of flow
PI3	Mine drainage to adjacent waterways and off-site terrestrial areas based on size and vegetative cover of refuse area
PI4	On-site impoundments affected by mine drainage (based on size)
PI5	Off-site terrestrial areas and impoundments affected by mine drainage (based on size)
PI6	Exposed gob based on acreage and vegetative cover of area
PI7	Exposed slurry based on acreage and vegetative cover of area
PI8	Exposed tipple based on acreage and vegetative cover of area
PI9	Volume of gob refuse
PI10	Environmental locale of mine site

[a]See Appendix K for statements used to calculate values for Problem Indices and total Problem Index Points.

APPENDIX K

PROGRAM STATEMENTS USED TO CALCULATE PROBLEM INDEX POINTS (PIP) FOR ABANDONED UNDERGROUND MINES[a]

```
 SELECT IF       (VAR032 EQ 4 OR 5 AND VAR016 EQ 1)
bIF              (VAR123 GE .1 AND VAR017 EQ 1)EXGOB=VAR123/VAR051
bIF              (VAR124 GE .1 AND VAR017 EQ 1)EXSLRY=VAR124/VAR068
bIF              (VAR125 GE .1 AND VAR018 EQ 1)EXTIPL=VAR125/VAR093
 IF              (VAR106 EQ 2 OR 4 OR 5)MD1=25
 IF              (VAR020 EQ 1 AND VAR118 EQ 1)MD2=30
 IF              (VAR020 EQ 1 AND VAR120 EQ 1)MD3=20
 IF              (VAR020 EQ 1 AND VAR119 EQ 1)MD4=15
 COMPUTE         PI2=MD1+(MD2+MD3+MD4)/10
 COMPUTE         PI3=((MD2+MD3+MD4)*EXGOB)/100
 IF              (VAR099 GE 1)PI4=VAR126
 COMPUTE         PI5=VAR127+VAR128
 COMPUTE         PI6=EXGOB
 COMPUTE         PI7=EXSLRY
 COMPUTE         PI8=EXTIPL
 COMPUTE         PI9=(SQRT(VAR041))/10
 IF              (VAR015 EQ 5)PI10=2
 IF              (VAR015 EQ 6)PI10=4
 IF              (VAR015 EQ 3)PI10=8
 IF              (VAR015 EQ 8 OR 9)PI10=10
 IF              (VAR015 EQ 10 OR 11)PI10=12
 IF              (VAR015 EQ 1)PI10=14
 IF              (VAR015 EQ 4 OR 12)PI10=16
 IF              (VAR015 EQ 13)PI10=18
 IF              (VAR015 EQ 2 OR 14 OR 15)PI10=20
 IF              (VAR121 EQ 1)PIP=PI1+PI2+PI3+PI4+PI5+PI6+PI7+PI8+PI9+PI10
 IF              (VAR121 GE 2)PIP=PI1+PI2+PI4+PI5+PI6+PI7+PI8+PI9
```

[a]Variable names and values appear in Appendix B.

[b]EXGOB, EXSLRY, EXTIPL represent new variables for gob, slurry, and tipple areas based upon the amount of vegetative cover.